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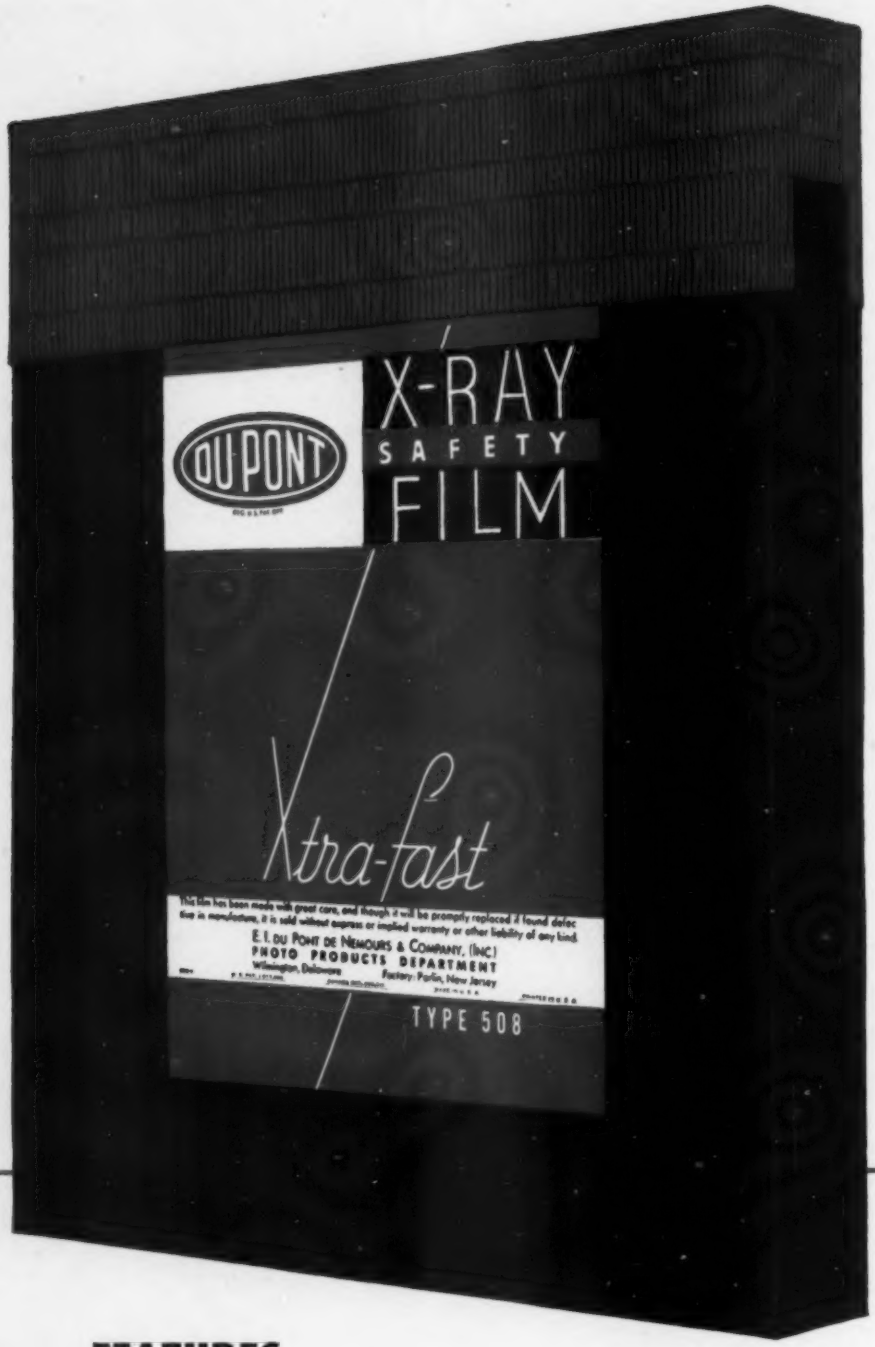

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THOMAS ALVA EDISON (1847–1931)
Circa 1887

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. 57 FEBRUARY, 1947 NO. 2

EDISON AND ROENTGENOLOGY

By ARTHUR W. FUCHS

MEDICAL DIVISION, EASTMAN KODAK COMPANY, ROCHESTER, NEW YORK

THE Centennial of the birth of Thomas Alva Edison on February 11, 1947, is fitting recognition of the enormous social, economic, and scientific influence Edison's discoveries have had upon our modern age. This great man was endowed with an inventive genius that had full play for a period greater than the average lifetime. As a consequence, the world now enjoys a distinctive civilization. As Americans, we are proud of the honor his work and benefactions gave to our country and the world.

Born of humble parents and with little formal education, the boy Edison early demonstrated his capacity for original investigation and independent study. His genius and effort made possible his rise from a newsboy to a position of leadership among men. A contributing factor, however, was his modesty, kindliness, and perseverance of character that were refreshingly stimulating to all who knew him.

As a "candy butcher" on the Grand Trunk Railway at the age of fifteen, he printed a newspaper on the train with a press consisting of parts he garnered from various sources. He learned telegraphy at fifteen and at the age of seventeen constructed a telegraph line between the Port Huron, New York, railroad station and the village. When twenty-one years old, he patented an electric vote recorder. Going to New York City poor and in debt at the age of twenty-two, he shortly obtained a job as a superintendent at $300 a month with the Gold Indicator Company, whose apparatus he repaired at the time he asked for a job. Within a year, he invented a stock ticker that could be synchronized with a master apparatus. For this he received $40,000 from The Gold and Stock Telegraph Company. At twenty-three, he opened a factory in Newark, New Jersey, to manufacture stock tickers and telegraph instruments.[1]

In Edison's twenty-fourth year, he assisted Christopher L. Shales, the inventor of the typewriter, in making the first successful working model. In the period between his twenty-fifth and twenty-ninth year, he completed many inventions—the automatic telegraph system in its many forms, paraffin paper, and the carbon rheostat. At twenty-eight, he discovered an electrical phenomenon that he called "etheric force" which, twelve years later, was found to be due to electric waves in free space and became the foundation of wireless telegraphy. A year later he established at Menlo Park, New Jersey, the first laboratory for organized industrial research.

The carbon telephone transmitter and phonograph were invented when Edison was thirty. He became actively interested

in electric lighting the following year and formed the Edison Electric Light Company.

The first practical incandescent electric lamp was invented by Edison at the age of thirty-two. He also made radical improvements in dynamo construction and power lines. At thirty-three, he invented the magnetic ore separator and started the first passenger electric railway at Menlo Park, New Jersey.

In the period of his life between thirty-three and forty, Edison took out upwards of three hundred patents largely concerned with improving electric light, heat, and power systems. Between forty and forty-four, he obtained over eighty patents on improvements of the cylinder phonograph. At forty-two, he made the first projection of an experimental motion picture that was accompanied by synchronized sound from a phonograph record. The motion-picture camera was patented July 31, 1891, when he was forty-four. It employed the tape-like film, originated by George Eastman, that is so familiar to us today. On April 14, 1894, the first commercial showing of motion pictures took place using a projector made by Edison called the *kinetoscope*.

The first news of the discovery of the x-rays appeared in the newspapers when Edison was forty-nine years of age; four days thereafter Edison had confirmed Röntgen's findings. In the thirty years prior to his fiftieth birthday, hundreds of basic inventions were made by Edison—the record is phenomenal.

When the discovery of the roentgen rays was announced, Mr. Edison's intense interest in new scientific advances compelled him to drop for a time active development of magnetic ore separating processes and plunge into the new field with tremendous energy and enthusiasm.

Theories regarding the nature of the roentgen rays were rampant, and Edison's views were as stubbornly advanced as others. Edison, however, backed his theories with practical demonstrations that perhaps in many instances were misinterpreted in the light of our modern knowledge. But they did serve at that time to spur investigators to greater and greater efforts to discover all they could about Röntgen's rays.

Edison's first investigations consisted of the determination of roentgen-ray permeability of hundreds of substances. Simultaneously, he constructed his own roentgen-ray tubes and apparatus that were used by himself and others. In 1896, tubes were low in roentgen-ray output and in an effort to increase the amount of radiation, he rapidly improved the design and operability of his tubes and the fluorescent screen.[2]

EDISON'S ROENTGEN-RAY TUBES

The scarcity of adequate tubes to produce roentgen rays stimulated many to make their own. Among the first was Edison whose knowledge regarding the fabrication of incandescent electric lamps placed him in a privileged category. Working in his Orange, New Jersey laboratory, one of his first tubes, about 6 inches in length (Fig. 1, *right*), was composed of an ordinary 16 c.p. incandescent lamp, into the top of which was fused a platinum wire, carrying a disk $\frac{3}{4}$ of an inch in diameter, made of polished aluminum. In the side of the lamp bulb there was fused a cathode terminal, consisting of an aluminum disk $1\frac{1}{4}$ inches in diameter, placed at right angles to the upper (anode) disk.

The thickness of Edison's incandescent lamp bulb was 1/64 inch and offered less resistance to the passage of the roentgen rays than the glass of the Crookes tubes then in use. Edison's tube differed from those of many experimenters in that he believed the vacuum of the tube should be adjusted to the voltage that was to be passed through the tube during its operation. Using an induction coil and applying voltage to the tube sufficient to produce a 4 inch spark, he found that the best point at which to seal off the lamp from the pump occurred when the glow within the interior of the lamp ceased and the fluorescence of the glass alone was observed.

Edison employed aluminum disk electrodes instead of the simple platinum wires

used in other tubes, because the disks remained relatively cool even under continuous tube operation, whereas the platinum wire electrodes heated excessively and interfered with results. The first Edison tubes contained atmospheric air before evacuation. Later, Edison expected to fill them with hydrogen and then exhaust, believing that a more "sensitive" vacuum could be obtained and lead to better results. The amazing fact about these Edison tubes was that they were to be made and sold *at a profit—for 50 cents*!

The *Electrical Engineer*[3] of March 18, 1896, described some interesting facts evolved by Mr. Edison and his associates, E. J. Houston and A. F. Kennelly, regarding the manufacture of roentgen-ray tubes. They found the best degree of vacuum was one reached when the applied voltage produced fluorescence in the glass and all other luminescence disappeared. Thin-walled tubes permitted more roentgen rays to be emitted, thereby producing a greater roentgenographic effect, while they remained

Fig. 2. Drawing of Mr. Edison watching operation of apparatus and tube.[19]

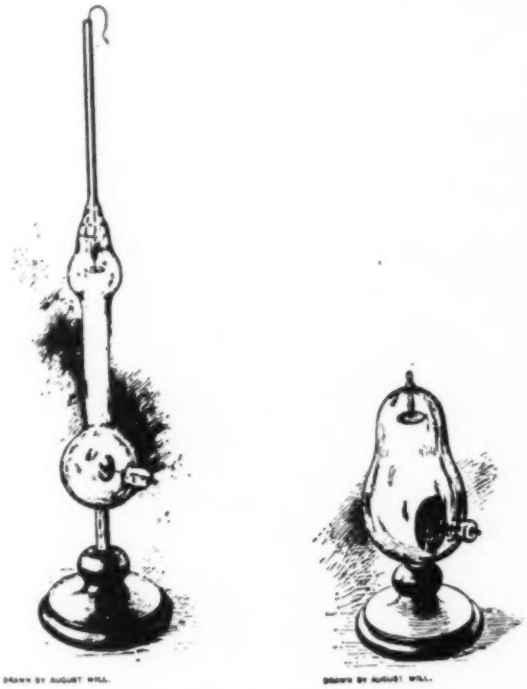


Fig. 1. Early forms of roentgen-ray tubes made by Edison before the advent of the focus tube.[21]

cooler than the thick-walled tubes. Such tubes produced a roentgen image on a "medium rapid" plate in about seven minutes at a distance of 3 feet! The roentgenographic power of a tube with a given degree of exhaustion increased with the surface area of its fluorescent wall, i.e., a large tube produced more roentgen rays than a small one, but it also required greater voltage.

Edison found that, after a tube had been satisfactorily evacuated and permitted to rest several hours and then re-energized, it acted as if it had a low vacuum and consequently had to be repumped. About 80 per cent of the tubes made reacted in this manner.[4] Modern tube makers would attribute this condition in part to the fact that all molecules of residual gas had not been driven from the substance of the metal electrodes, and upon standing these molecules oozed into the evacuated space.

Greater efficiency of tube evacuation at the time was impossible because of the inadequacy of the mercury pumps then in vogue.

Edison also found that as the roentgen-ray tube was moved to a greater distance from the plate, sharpness of the image increased with less distortion. Small tubes were found to produce sharp images at short distances and were useful for "short" exposures. Small tubes with thin glass walls measured . inch in diameter with a distance of 2 inches between electrodes and were made to suit the capacity of any induction coil. Edison early found that the type of glass most transparent to roentgen rays, and therefore good for fabrication of tubes, was of the type employed in the making of photographic plates. Later, however, it was discontinued because the physical characteristics of the glass were such that it became too brittle after heating and roentgen-ray bombardment.

A means for regulating the vacuum of roentgen-ray tubes soon developed. Edison and his associates constructed a small auxiliary tube containing a substance that when slightly warmed gave off a vapor that lowered the vacuum and enabled the current to pass at the voltage required for satisfactory operation.[18] This auxiliary tube was fused onto the top of the roentgen-ray tube.

THE FLUORESCENT SCREEN

Many early roentgenograms were made of inanimate objects. The interest in this type of roentgenography soon passed to the possibilities of studying moving objects, which in turn led to the development of Röntgen's barium platinocyanide fluorescent screen into the fluoroscope. Soon, in February, 1896, fantastic, vague, and startling reports emanated from the foreign press[5] regarding a wonderful device "invented" by Professor Salvioni of Perugia, Italy, called the *cryptoscope*, that permitted instantaneous visualization of human, living, and moving bones, and other animate subjects. The instrument consisted of a cylinder of cardboard. At one end was mounted a piece of cardboard smeared with a mixture of barium platinoncyanide crystals and probably varnish. The other end was provided with a lens. When the object to be studied was placed between the roentgen-ray tube and the fluorescent end of the device, "by applying the eye to the lens, the observer sees on the fluorescent substance the shadow of the objects that are impenetrable to the rays." Details of structure were not visible since the fluorescent image was really only a proof of the transparency of objects to the roentgen rays.

At about the same time Professor McGie of Princeton University also developed a fluoroscope in principle the same as Salvioni's. This instrument was called a *skiascope*. Edison also constructed a similar device about which extensive publicity soon developed. He named it the *fluoroscope* and the term has come down to us through the years.

Chemistry always fascinated Edison, and this interest led to his thorough investigation of chemicals that would fluoresce under the action of the roentgen rays. One day he pointed out to his assistant, Aylsworth, a whole section of his chemical room and said,

> Aylsworth, start up there at the top and work down. If there is a suitable fluorescent salt or a combination of salts that will fluoresce we will get it. Stick at this and let me know from what substances you get results.[6]

Thus was begun a search that ultimately involved testing of thousands of substances for fluorescent effects.

After making an exhaustive investigation, Edison adopted calcium tungstate as the proper fluorescent salt most suitable for roentgen-ray work because of its greater fluorescence and its relatively smaller afterglow. Many substances were found that had greater fluorescent power, but the tremendous afterglow ruled them out. After proving the efficiency of his new screens, Mr. Edison turned over their manufacture, under his direction, to Aylsworth and Jackson of Orange, New Jersey, who marketed the screens for several years.[7]

It was particularly fortunate that Edison

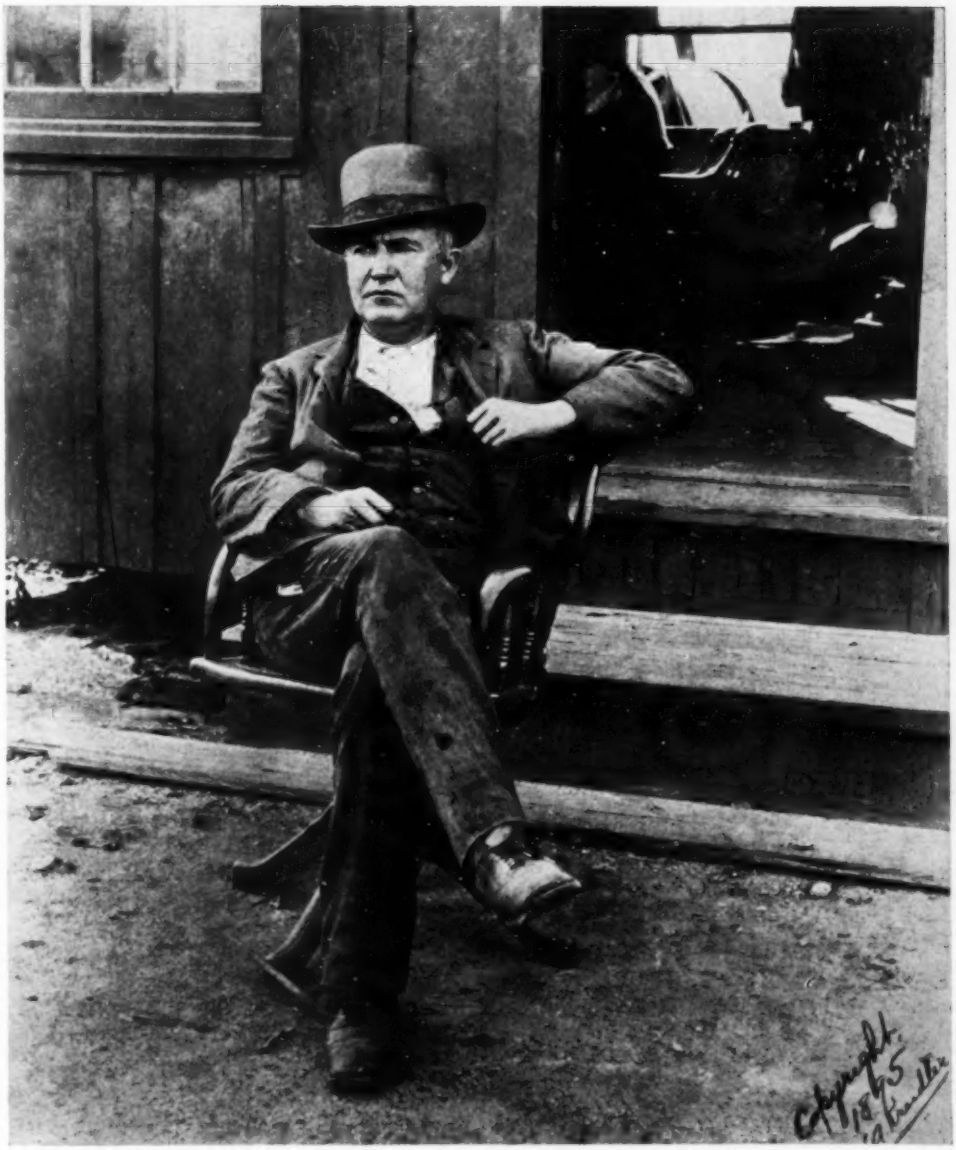


Fig. 3. Thomas Alva Edison sitting before his ore reduction laboratory (1895).[1]

found calcium tungstate screens to emit a more satisfactory fluorescence since the light is confined largely to the blue end of the visible spectrum and is therefore more sensitive to roentgen-ray plates and films.

Certainly Mr. Edison was one of the early vocal enthusiasts in April, 1896, who stimulated medical interest in the infant field of roentgenology and incited the feverish medical activity that was to determine eventually its usefulness in medicine and surgery. Medical roentgenograms soon appeared profusely in all the current literature and were viewed with awe and frequently humorous skepticism.

An interview with Edison in those early days is typical of the enthusiasm that prevailed. Referring to the use of his fluoroscope, Edison is quoted[8] as of April, 1896:

> The appliance [fluoroscope] is for immediate use, and is a valuable aid to surgery and would be invaluable in a hospital. Suppose a man should fall and break his arm and be taken to a hospital. It is very important that this fracture should be properly set at the start. If this is not done, the arm may have to be broken again and again until it is properly set, which, of course, means so much extra pain for the patient and a wearisome postponement of his convalescence. With the apparatus [roentgen ray] you see here and the fluoroscope a surgeon can detect the nature of the fracture in a moment and set the arm accordingly.

The editor of the publication in which the above appeared seemed rather dubious about the whole matter and also Mr. Edison's integrity, for he remarked editorially,

> All of the above reads very nice, but still it smacks greatly of the sensational journalism, and until we hear of practical demonstrations by scientists of note and reputation who will show results, the glowing account of the fluoroscope will form a companion to the bright fairy tales . . . .

Edison prepared his crystalline calcium tungstate by fusing together anhydrous sodium tungstate and calcium chloride. It was then finely ground and mixed with collodion as a binder and spread on paper, cardboard, or thin aluminum sheets.

The first person to apply the active side of a fluorescent screen to the sensitive side of a photographic plate for the purpose of reducing the time of exposure in roentgenography was Professor Michael Pupin of Columbia University, in February, 1896.

Professor Pupin had equipment to produce roentgen rays early in 1896, and being dissatisfied with the exceedingly long exposures necessary to produce satisfactory images, made every effort to increase the efficiency of his apparatus. He therefore decided to place the fluorescent screen next to a photographic emulsion and make an exposure. This procedure in Pupin's words[9] is described as follows:

> The famous surgeon, the late Doctor Bull of New York, sent me a patient with nearly a hundred small shot in his left hand. . . . He was in agony; he and I had mutual friends who begged me to make an x-ray photograph of his hand and thus enable Doctor Bull to locate the numerous shot and extract them. The first attempts were unsuccessful, because the patient was too weak and too nervous to stand a photographic exposure of nearly an hour. My good friend, Thomas Edison, had sent me several most excellent fluorescent screens, and by their fluorescence I could see the numerous little shot and so could my patient. The combination of the screen and the eyes was evidently much more sensitive than the photographic plate. I decided to try a combination of Edison's fluorescent screen and the photographic plate. The fluorescent screen was placed on the photographic plate and the patient's hand was placed upon the screen. The x-rays acted upon the screen first and the screen by its fluorescent light acted upon the plate. The combination succeeded, even better than I had expected. A beautiful photograph was obtained with an exposure of a few seconds. The photographic plate showed the numerous shot as if they had been drawn with pen and ink. . . . That was the first x-ray picture obtained by that process during the first part of February 1896, and it was also the first surgical operation performed in America under the guidance of an x-ray picture.

The more brilliant visual image of Edison's new fluorescent screen in 1896 was a distinct improvement over the earlier barium platinocyanide types, since the time of roentgenographic exposures could be

materially reduced. It gave further impetus to the use of photographic plates, since the effect of the roentgen rays was cumulative and fluorescent images were only faintly perceptible, particularly of heavy parts; roentgenographic images of great density could be produced simply by prolonging the exposure.

An early (1896) rule was evolved by Edison and others regarding the intensity of the roentgen rays, i.e., that the intensity varies as the square of the focus-film distance. And the increased speed Edison attributed to his new calcium tungstate screens was based on the foregoing rule and found to be six times greater than when using a barium platinocyanide screen.

Fluoroscopic screens, made by Aylsworth and Jackson under Edison's direction, possessed an actinic value that ultimately reached ten times that given off by barium platinocyanide crystals. The screens had objectionable lag, and in the light of modern requirements they deteriorated rapidly. However, they were considered the best in 1896.

The screens incorporated in the Edison fluoroscope consisted of a piece of calendered cardboard upon which calcium tungstate crystals were retained in position by a matrix of collodion.[10] The screen was inserted in a truncated, pyramidal box; a handle was attached to one side. The open, narrow, curved end was shaped to fit closely over the eyes. This eyepiece was rimmed with black feathers to prevent light leakage into the box while the observer viewed the fluoroscopic image. The first public exhibition of this instrument occurred early in 1896 at the Electrical Exhibition in the Grand Central Palace, New York City, shortly after completion of the first model.

PUBLIC RESPONSE TO EDISON'S EXPERIMENTS

Sensationalism was the order of the day with respect to the newly discovered rays, and intelligent readers of newspapers made early complaint to their editors regarding publication of absurd claims. Their very sensational character, of course, was too great for even some of the best editorial thought. Edison's tremendous popularity provoked great interest in any roentgen-ray work performed by him. In the *Electrical Engineer* of February 19, 1896, appeared the following letter that had been sent to the *New York Herald:*

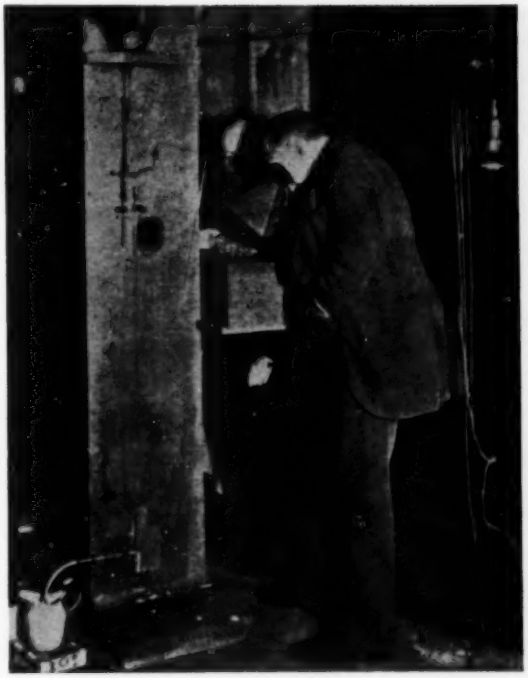


Fig. 4. Mr. Edison shown operating his fluoroscope and roentgen-ray apparatus that was used at the Electrical Exposition. Note mercury pump used to evacuate tube.[13]

I notice with regret the rush of sensational articles in the daily press in connection with the new cathodography. It is a great pity that much misleading matter is laid before the general public mixed with some that is of profound value and the confusion, loss of respect, etc., which must follow, must result in injustice to the profession [medical].

The articles which have heretofore appeared in the "Herald" upon the subject have been clear, of intense interest and scientific value, but a day or two ago I saw one of a different character on restoration of life, and today a large illustrated article on brain photography, which is not only void of professional dignity and lacking in taste, but bears unmistakable signs perfectly apparent to the serious reader of its real nature. As for the accompanying illustrations of "his own brain," how is it that if the

picture is obtained by rays passing through the head the picture is one showing a few surface veins and marks upon the surface of the brain, such as are used to illustrate elementary textbooks. . . .

This letter preceded a comment by Edison in which he confidently announced that in the near future he would be able to "photograph" the human brain through the heavy bones of the skull and perhaps even the bony skeleton through the tissues of the body. This provoked an enormous public response, and Edison received hundreds of letters and the newspapers elaborated with rhetorical gush.

William Randolph Hearst on February 5, 1896, wired the following urgent request:

Will you as an especial favor to the Journal undertake to make Cathodograph of human brain. Kindly telegraph answer our expense.

A New York physician[11,12] startled the medical profession and public, as evidenced by the letter to the *New York Herald* above, with his method which was reported fantastically by an apparently confused interviewer as follows:

For three years past Dr. Simon had been working quietly towards his end. Reports of Professor Rontgen's discoveries and Mr. Edison's experiments hastened his researches, and yesterday his labors were rewarded by results which though still incomplete, were fairly satisfying. An ordinary camera with platinum plates was employed.

Doctor Simon was not prepared or willing to explain his seemingly confused process in detail. In a statement to an interviewer, however, he said:

The rays I use in conjunction with sound, and they are electric rays so far as the light is concerned. I produce the effect by attraction of the light and propulsion through the brain substance. At the time of photographing the whole internal chamber of the brain is illuminated.

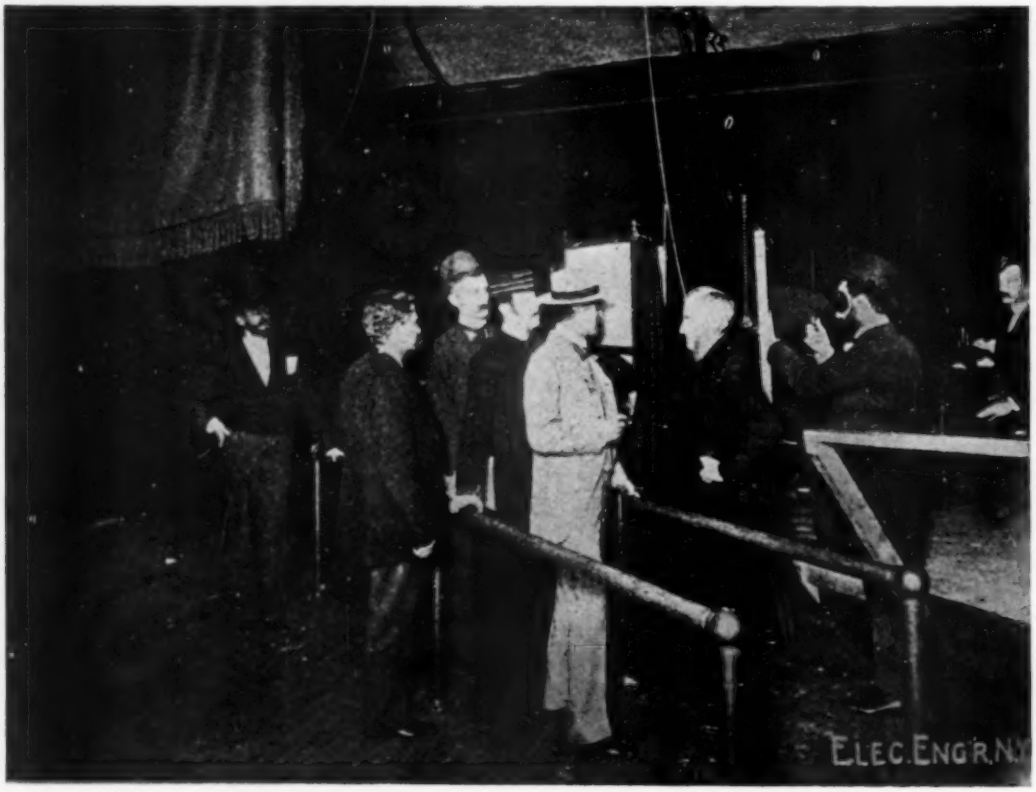


Fig. 5. The Edison roentgen-ray set-up at the Exposition (1896).

My discovery is not consequent on the application of the cathode ray to photography.

Another type of urgent communication was also received at Edison's laboratory and the following is a typical example in the sender's original grammatical form:

Jersy City Mar 3th 96
Mr. thomis Edison
Dear Sir
i have Been Reading so mutch about the x Rais that i would Like to have my Brains Photograf
i would Like to Be one of the first ones to have them taken if their is any things in it
Yours Rest

I. G. Buch
563 Grove Street
Jersey City, N. J.

All of this publicity, good or bad, served to stimulate others in their efforts to accomplish the "impossible," and it is a credit to the actively functioning and intelligent minds of workers in the field that skull roentgenography became an actuality in the subsequent years. To our knowledge, however, Edison became engrossed in his other multitudinous experiments and never made a roentgenogram of a "brain."

EDISON'S ROENTGEN-RAY APPARATUS

In early April, 1896, Edison built four "portable" roentgen-ray outfits that were installed during the 1896 National Electrical Exposition in New York City. These outfits were so arranged as to allow anyone to step up and look at his own hand fluoroscopically and were to be operated by members of his staff.

Mr. Mallory, Edison's associate, tells a characteristic story of Edison's share in this historic exhibit:

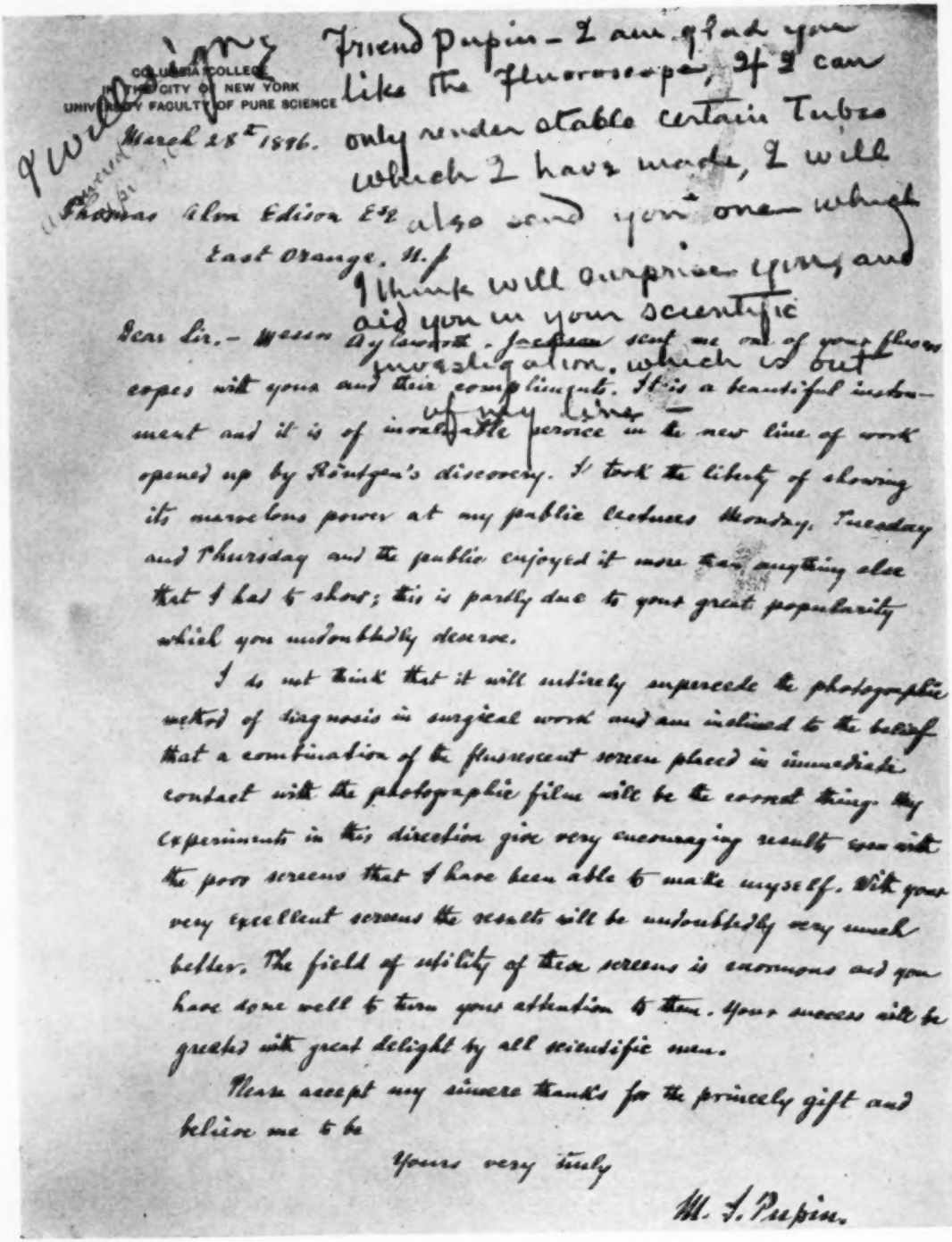
The exhibit was announced for opening on Monday. On the preceding Friday all the apparatus, which included a large induction-coil, was shipped from Orange to New York, and on Saturday afternoon Edison, accompanied by Fred Ott, one of his assistants, and myself, went over to install it so as to have it ready for Monday morning. Had everything been normal, a few hours would have sufficed for completion of the work, but on coming to test the big coil, it was found to be absolutely out of commission, having been so seriously injured as to necessitate its entire rewinding. It being summer-time all the machine shops were closed until Monday morning, and there were several miles of wire to be wound on the coil. Edison would not consider a postponement of the exhibition, so there was nothing to do but go to work and wind it by hand. We managed to find a lathe, but there

Fig. 6. Early experimental Edison fluoroscopes (1896)[1]

was no power; so each of us, including Edison, took turns revolving the lathe by pulling on the belt, while the other two attended to the winding of the wire. We worked continuously all through that Saturday night and all day Sunday until evening, when we finished the job. I don't remember ever being conscious of more muscles in my life. I guess Edison was tired also, but he took it very philosophically.

Mr. Edison is shown (Fig. 4) operating one of the roentgen-ray machines. The method of operation is quoted[13] as follows:

The hand rests on a box which contains the battery, the induction coil and the Crookes tube. When the current from the battery is switched on to the coil and tube, the mercury pump seen on the upright board is also started, so that the tube is undergoing exhaustion while in operation. Mr Edison has found that the tube works much better while thus used.



COLUMBIA COLLEGE
IN THE CITY OF NEW YORK
UNIVERSITY FACULTY OF PURE SCIENCE

March 28th 1896.

Thomas Alva Edison Esq
East Orange, N.J.

Dear Sir.- Messrs Aylsworth & Jackson sent me one of your fluoroscopes with yours and their compliments. It is a beautiful instrument and it is of invaluable service in the new line of work opened up by Röntgen's discovery. I took the liberty of showing its marvelous power at my public lectures Monday, Tuesday and Thursday and the public enjoyed it more than anything else that I had to show; this is partly due to your great popularity which you undoubtedly deserve.

I do not think that it will entirely supercede the photographic method of diagnosis in surgical work and am inclined to the belief that a combination of the fluorescent screen placed in immediate contact with the photographic film will be the correct thing. My experiments in this direction give very encouraging results even with the poor screens that I have been able to make myself. With your very excellent screens the results will be undoubtedly very much better. The field of utility of these screens is enormous and you have done well to turn your attention to them. Your success will be greeted with great delight by all scientific men.

Please accept my sincere thanks for the princely gift and believe me to be

Yours very truly

M. I. Pupin.

Friend Pupin - I am glad you like the fluoroscope, if I can only render stable certain Tubes which I have made, I will also send you one which I think will surprise you and aid you in your scientific investigation. which is but of my time -

FIG. 7. Letter from Professor Pupin to Mr. Edison discussing his experimental work dated March 28, 1896. Edison's reply is in pencil and dated April 2, 1896. This reproduction is a unique duo-autograph of two great men.[1]

PROF. RAY
BRAIN EXPERT
KNOW YOUR MENTAL CAPACITY BY THE NEW AND MYSTERIOUS X RAY PHOTOGRAPH
EMPTY.
PROFESSOR RAY (*after a vain search, musingly*)—"How shall I break it to him?"

FIG. 8. Cartoon from *Judge*, April 11, 1896, satirizing "brain photography."

As will be seen, this apparatus can be set on wheels and rolled around a hospital, or put on the cars and shipped to the scene of a railroad wreck. At the exposition, people will be allowed to look at their own hands on the box, if they choose; but if they linger the circuit will be broken. In this way the procession will be kept moving.

Edison's exhibition of his roentgen-ray apparatus was so successful that long lines of people stood each night for the opportunity to "see their bones."

In the war with Cuba, roentgen-ray apparatus made by the Edison Manufacturing Company was installed on the U. S. Naval Hospital Ship *Solace*.[14] It was installed forty-eight hours after receipt of the order!

EDISON'S FLUORESCENT LAMP

As a side development of the Edison roentgen-ray tube was Edison's construction of a fluorescent lamp announced in the June 3, 1896, issue of the *Electrical Engineer*. Edison fused calcium tungstate crystals to the inner surface of a roentgen-ray tube. When the tube was operated, most of the roentgen rays were absorbed by the crystals with resultant fluorescence of about 1 candle power intensity. No evidence of roentgen rays was detected outside, and the tube remained relatively cool. This tube was the progenitor of the modern fluorescent lamp now in common use. Mr. Edison, however, was discouraged in developing the tube further at that time because it was later found to emit roentgen rays outside the glass when highly energized. It therefore became a dangerous source of illuminant for reading or working purposes. Later he made fluorescent lamps employing other fluorescent substances that had greater actinic properties than the

tungstate salt, the intensity being 3–4 candle power.

THE EDISON EFFECT

An important observation was made by Edison in 1883 while working with incandescent lamps. Noting that bulbs blackened with use, he decided to determine the reason for the phenomenon. He sealed a metal plate into the lamp and connected a galvanometer to the electrodes; the galvanometer needle was deflected indicating a flow of current from the filament to the plate across a gap.

We know today that the incandescent filament acting as a negative electrode produced electrons that flowed to the plate or positive electrode. Edison had discovered the basic principle—"Edison Effect"—of the modern radio and rectifier tube that made possible broadcasting, long-distance telephony, and television. He patented the tube but never used it. Later Fleming developed it for rectifying currents, and today the principle is incorporated in the valve tubes of roentgen-ray apparatus. DeForrest also used the Edison effect for his radio tubes.

* * *

Mr. Edison's interest in the roentgen rays was soon lost in numerous other projects occupying his attention. The manufacture of cement in 1901 grew out of his iron-ore concentrating venture; improvements in the Edison alkaline battery were being rapidly made; and, in 1907, the universal electric motor was developed. Further work on the phonograph improved the reproduction of vocal and instrumental music. The *kinetophone* for talking motion pictures was produced in 1913.

The diversity of effort of this remarkable inventor was astonishing for, in the remaining years of his life, he developed a process for making synthetic carbolic acid, invented a telephone and dictating phonograph, established factories for the manufacture of fundamental coal-tar products, and developed a method for making synthetic rubber.

Edison was perhaps the last of the Titans of basic invention, for in the modern complexity of scientific development, no single man could ever again hope to achieve a comparable multitude of discoveries. Of 1,097 patents issued to Edison, 356 deal with electric lighting and power distribution.

Humble tribute should be made to this man who, without the aid of armies, has shaped a civilization more lasting than one ever enlivened by an ideology. The resultant social and economic benefaction has reached the highest and the lowliest in the comfort, warmth, and light of his discoveries.

Eastman Kodak Co.
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TREND TOWARD CANCER SPECIALIZATION*

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THE American Radium Society resumes activity after a four-year lapse of time due to World War II. This is the only interruption in the annual meetings since the organization of the Society thirty years ago.

During the past thirty years the American Radium Society has played a unique role in cancer therapy in the United States. The charter members were eminent authorities in cancer diagnosis and therapy of that decade. Radium was the recently acquired cancer weapon at the time of the organization, and the Society was aptly named The American Radium Society. The membership included surgeons, gynecologists, urologists, laryngologists, pathologists, physicists, dermatologists and radiologists. These men were profoundly interested in cancer. The Society has continued to add to its membership roster those interested in cancer and actually doing cancer work. The programs in the past presented many instructive articles on the pathology and treatment of cancer.

Suggestions have been made regarding the merger of this Society with one of the radiological societies. It is probable, as pointed out by Dr. Eugene P. Pendergrass after his splendid and thorough study of the problem, that the consensus would be that a merger would be unwise.

The American Radium Society has occupied an unparalleled position as the predominant clinical cancer society. With our rich heritage and solid background, nothing should prevent us from maintaining this Society as the leading clinical body interested in promoting the study and treatment of cancer.

Suggestions have been made as to changing the name of the Society from that of the American Radium Society to some title which would more clearly indicate that the members are interested in cancer from every standpoint instead of the radium aspect only. Of course, our own members know that most of their colleagues are and always have been interested in all phases of cancer. Such a change should be considered. However, regardless of the decision of the present membership, this Society, as progeny of cancer-minded pioneers, is destined to carry on, as a group whose interests are primarily the problems of research and treatment of cancer.

There have been many changes in the technique of cancer therapy during the past quarter of a century. In the treatment of some types of cancer, the pendulum has swung from radical surgery to radical radiation therapy, and vice versa. Nevertheless, as time has passed, the indications for and limitations of both methods have been observed and studied. The men who have been most successful in the treatment of cancer have been those who understood the rationale of all methods of treatment and intelligently applied their experience and knowledge.

Radium and roentgen-ray therapy have been inseparable. In the earlier days of the use of radium some physicians used this modality alone in the treatment of cancer. Most observers soon found that the roentgen ray and radium were so closely allied in their action and effects that, when dealing with a wide variety of tumors, it was practically impossible to use one advantageously without the other.

Radiation therapy has been employed in all specialties both surgical and medical. In fact, radiation therapy and surgery have many things in common in that they both invade practically all the recognized specialties. Often, the same patient will require

* President's Address delivered at the Twenty-eighth Annual Meeting of the American Radium Society, San Francisco, Calif., June 28–29, 1946.

both surgical and radiological procedures. This calls for either the services of a physician with training and experience in all branches of cancer therapy, or for the cooperation of a trained group who pool their special knowledge and work together as a team.

Radium, soon after its discovery, was used in the treatment of carcinoma of the cervix. It still plays a major rôle in the therapy of this disease. A number of pioneers in the American Radium Society were gynecologists and their work with radium in the treatment of carcinoma of the cervix was outstanding. Their careful observations and unbiased opinions aided in establishing radium and roentgen therapy as the method of choice in the treatment of carcinoma of the cervix. It is still the method of choice today, with surgery being considered by some in only the very early involvements of the disease. Some of the gynecological pioneers of this Society spent years in developing their technique with the radical Wertheim operation. They turned to radiation methods not so much because of their primary mortality (which was higher then than it would be now due to our more advanced methods of anesthesia and chemotherapy) but because their experienced observations pointed out to them the high incidence of recurrence which followed their most careful and radical surgery. If we consider the method of treatment of the early cervical carcinoma to be a debatable question, the fact remains that in the average cancer clinic only 10 per cent or less of cervical cancer patients seeking aid are in the early or operable stage. Consequently, the large group suffering from this condition must be considered as radiological problems. Improvement in the technique of radiation therapy, by trained and experienced therapists, is saving more and more of these advanced cases as time goes on.

Throughout the years the American Radium Society, through its comprehensive programs, has aided in the development of all branches of radiation therapy and has done much to dispel the misinformation and misunderstanding which arose regarding the use and abuse of this rapidly developing specialty.

After the discovery of radium, its widespread use in the treatment of uterine fibroids and hemorrhages at the time of the menopause caused some surgeons and gynecologists to express doubts and prophecies regarding the effects of this type of therapy. Later experience proved that the majority of the prejudices were unwarranted. The women did not have all the undesirable menopausal symptoms or loss of sex, as often alleged. Consequently, a number of gynecologists, several being members of this Society, adopted and developed radiation methods as a valuable adjunct to their armamentarium.

For many years there has been a trend toward the training of physicians for clinical work in the field of cancer as a specialty. Certainly, a disease which rates as the number two killer of our population deserves to be considered from all angles of research and clinical procedure by properly qualified medical workers. Cancer at the present time is being considered as a disease entity and men are being trained in various types of research and clinical methods for its control. Regardless of the name we apply to these individuals—oncologists, cancer specialists, etc.—it is certain that the future will produce many physicians and groups of physicians who will devote their lives to the study and treatment of cancer.

The American Radium Society, by presenting through its programs the developing knowledge on cancer, has encouraged specialization. We would do well to include in our membership all qualified men who are interested in and working in this field. Possibly the time has arrived when this Society should encourage the American College of Surgeons and the American Medical Association, by means of joint committees, to acknowledge the value of specialized training in the cancer field and ultimately to recognize this particular training as a specialty within the profession.

There is an increasing need for thoroughly trained physicians who will follow the advanced as well as the early cancer case and give aid and palliation. The hopeless feeling shown by many physicians toward cancer is unjustified. There is also an appalling need for adequate hospitalization for the advanced and terminal cancer patient. Trained physicians with sufficient hospital facilities could prolong the lives of these unfortunate persons, give them increased palliation and obtain occasional cures.

It is the duty of the American Radium Society to be interested in these special cancer problems as well as in all aspects of cancer work. Certainly, this venerable Society, the only organization in this country whose programs deal chiefly with the problems of the clinical diagnosis and treatment of cancer, will continue to sponsor developments and direct efforts toward the discovery of the cause and cure of cancer.

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CANCER OF THE EYELID TREATED BY RADIATION

WITH CONSIDERATION OF IRRADIATION CATARACT*

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THE literature on cancer of the eyelid has carried preponderant support for radium therapy[2,6,14,32,33,34] in preference to roentgen therapy.[35,40] While this choice was apparently justified at one time, it is no longer merited, in our opinion. Radium therapy as practiced ten to twenty years ago was generally superior to roentgen therapy in its accuracy, convenience and more dependable control of cancer with superior cosmetic and functional results. Our experience of that period upheld the generally current attitude. Since that time, roentgen therapy has gained maturity and grown in stature due to the essential contributions of more accurate and generally available dosimetry, together with the provision of more adaptable, safe and dependable facilities for roentgen therapy. The clinical radiologist is forever indebted to the physicist, not only for the discovery of his armamentarium, but also for establishing and teaching the principles of their control and application.[12] Manufacturers have made indispensable contributions in the development of simple reliable measuring instruments such as the Victoreen r-meter, and the shockproof, rayproof roentgen tubes, and dependable energizing equipment now available. Present roentgen-ray equipment permits the application of radiation of controlled intensity and graduated penetration to more localized areas and at shorter distances, thereby acquiring differential depth dosage advantages previously provided only by radium therapy.

In the early literature,[1,5,23,36] cataract was far more commonly observed after treatment of cancer of the eyelid by roentgen rays than after treatment by radium. On the other hand, eyeshields are now available which effectively screen the eyeball and lens against primary roentgen rays, but such shields offer no significant protection against the more penetrating gamma rays of radium.

The present survey of cancer of the eyelid is based on 100 patients selected from the 134 cases seen from 1930 to 1946. Of the 100 cases, 41 were private patients and 59 were dispensary cases. An analysis will be made in order to disclose certain clinical aspects of the disease, to evaluate the proper rôle of roentgen rays, radium and surgery in treatment, to consider the procedures and precautions to be observed for avoidance of irradiation cataract, and to evaluate reasons for therapeutic failure.

INCIDENCE AND ETIOLOGY

Cancer of the eyelid is one of the common forms of cancer, representing 9 per cent (Hollander and Krugh),[15] to 17 per cent (Driver and Cole)[9] of cancer of the skin. Keratoses or frank carcinomas of the skin elsewhere are commonly associated, being present in 28 per cent of our patients, about one-third of Sharp's cases,[34] and in 47 per cent of the cases seen by Driver and Cole. Three of our patients developed cancer of both right and left eyelids (see Case 1), while 2 cases showed two independent lesions about the one eye. Sharp has noted a similar bilateral and multiple occurrence of carcinoma of the eyelid. Cancer of the eyelid afflicts primarily the older age group, 78 per cent of this series being sixty or more years of age, although ages varied from nineteen to ninety years; in Sharp's series, 70 per cent were sixty years of age or older.

The distribution of cancer of the eyelid between the sexes shows a somewhat higher incidence in men—66 men and 34 women. In a series of 500 cases collected from vari-

* From the Department of Radiology, University of Nebraska College of Medicine, Omaha, Nebraska. Presented at the Twenty-eighth Annual Meeting, American Radium Society, San Francisco, Calif., June 28–29, 1946.

ous sources by Lane,[19] 60 per cent of the cases were men. The distribution of our cases between the sexes was practically equal in private practice, 20 men and 21 women, which is in keeping with Robinson's report;[33] whereas in the clinic group there were 46 men and 13 women.

The etiology of cancer of the eyelid appears related to environmental, irritational and certain constitutional factors common to cancer of the skin in general as shown by its association with cancer of the skin in other areas. The higher incidence of cancer of the eyelid noted in men of the clinic group probably results from their greater exposure to sun and weather, they having been primarily laborers and farm workers. This interpretation is supported by Lane, Driver and Cole, Sharp, and others. Lane noted a somewhat higher incidence among sedentary scholars and there is a remarkably high incidence among housewives, both of which may be related to chronic irritation by spectacle frames. Driver and Cole noted the cancer to be located directly beneath the spectacle rest in 17 per cent of their cases. Lane and Sharp have noted that an excessive exposure to oil and petroleum products, as in automobile mechanics, is associated with some increased incidence of cancer of the eyelid. Sharp noted development of carcinoma in old scars, particularly those from thermal burns. The bilateral occurrence of carcinoma of the eyelid lends definite support to some individual constitutional tendency toward instability of mitotic control of tissues in that area. Case III in this series reported that a brother had died from cancer of the eyelid arising in the same region, which gives some slight support to a constitutional and familial predilection.

DIAGNOSIS

Cancer of the eyelid usually begins first as a small nodular thickening or elevation located directly adjacent to the lid margin. The lesion enlarges and extends very slowly as a rule, the mean duration of lesions being about six to twelve months in private practice and about two to three years in clinic practice. Many lesions are remarkably slow in development, since 30 per cent of our cases gave a duration of more than three years and 3 per cent a duration of more than ten years. Lane reported an average duration of cancer of eyelid of three to five years prior to reporting to cancer centers for treatment.

The consistency and appearance of cancer of the eyelid is usually, although not always, quite characteristic of the disease. The lesions present a hard, inelastic consistency with loss of pliability. The surface of the lesion presents a waxy, translucent sheen with telangiectatic capillaries through its surface in case the epidermis has been invaded. In areas where the carcinoma has extended beneath but not through the epidermis, the overlying skin may be surprisingly normal or only slightly atrophic in appearance. Ulceration with attending exudate and crusting results from an infarctive necrosis through areas of undernourished tumor tissue. The extent of ulceration and loss of lid tissue depends upon the state of nutrition through the neoplasm and upon the depth of its invasion. The more slowly growing lesions usually have presented hyperkeratotic precursors in the general nature of exfoliating keratoses, seborrheic plaques, keratotic horns or occasional papillomas.

Table I

AGE AND SEX DISTRIBUTION IN CANCER OF EYELID

Age Group	Male	Female	Total Cases
yr.			
10–19	1	0	1
20–29	0	0	0
30–39	1	0	1
40–49	1	2	3
50–59	11	6	17
60–69	19	12	31
70–79	26	8	34
80–89	6	6	12
90–99	1	0	1
Total	66	34	100

The clinical diagnosis of cancer of the eyelid involves a differentiation from benign neoplasms and inflammatory processes. Examination with the binocular loupe is frequently very helpful, both in ascertaining the extent as well as the nature of the lesion. Benign moles are not infrequently seen on the eyelid, usually being associated with moles elsewhere on the face, and are characterized by their prolonged history, a softer more elastic consistency, and their more or less brownish color. The protrusion of hairs through the mole is reliable evidence of its benignity.[38] Melanocarcinomas usually show a slaty-blue color, present no hairs, show poorly delimited borders, and tend to be more friable and hemorrhagic than benign moles. Hemangiomas can usually be recognized by blanching under pressure and a collapsible consistency.

The so-called seborrheic warts are common about the forehead, nose and inner canthus, and present slightly elevated plaques with a more or less velvety, oily consistency. They tend to be multiple, extend slowly at their periphery, and may ulcerate centrally. They show less tendency to the development of carcinoma, however, than do the dry, scaly, senile hyperkeratoses. Xanthoma palpebrarum is readily differentiated by the distinctive yellow color and the soft consistency of the intradermal deposits, which most often are multiple and located about the inner canthus.

Inflammatory lesions of the eyelid differ from carcinoma by their more rapid development, the clinical signs of inflammation, the more elastic consistency of the induration, and spontaneous regression under conservative therapy. Molluscum contagiosum presents an umbilicated granulomatous lesion. Chalazion is suggested by a subcutaneous, rounded, encapsulated nodule in the lid substance. The most confusing lesions encountered in our experience are small, indolent, inflammatory nodules at the margins of the eyelid, such as described by Hollander and Krugh. The lesion presents a firm, infiltrative consistency due to surrounding connective tissue infiltration, which may be suggestive of cancer on clinical observation and palpation. Biopsy reveals the tumefaction to be in the nature of a foreign body reaction, which the authors attribute to the inclusion of a broken hair shaft or some such substance within the area. Resolution of such chronic inflammatory nodules is usually promoted by 200 to 400 roentgens of superficial roentgen therapy given with proper shielding of the eyeball.

HISTOPATHOLOGY

Microscopic examination may be essential for differentiation between cancerous and noncancerous lesions of the eyelid. Biopsy is not infrequently foregone in order to minimize loss of tissue and scarring of the lids. Small biopsies can usually be taken under local anesthesia, using iris scissors and iris forceps. In some of the smaller lesions a trial of conservative management by normal saline wet packs, penicillin creme, and low dosage roentgen rays may clear inflammatory lesions, and thereby solve the problem of differential diagnosis without biopsy. In the case of cancerous lesions, biopsy permits differentiation between the relatively benign basal cell carcinomas and the more malignant, potentially metastatic, squamous cell carcinomas. This is helpful, not only in the planning of treatment, but in giving a prognosis.

Microscopic examination of the lesion was performed in 70 of our 100 cases of neoplasms of the eyelid. Basal cell carcinoma constituted 48, or roughly 70 per cent, of these neoplasms. Squamous cell lesions were observed in 10 cases, or about 15 per cent of the lesions. Mixed squamous and basal cell carcinomas, sometimes called keratinizing basal cell lesions, were observed in 3 cases, or about 5 per cent. Keratotic horns were observed in 3 cases, and papillomas in 4 cases; the more benign lesions thereby constituting 10 per cent of the epithelial tumors. Benign nevi or moles were observed in 2 biopsied cases. This analysis shows a pronounced preponder-

ance of basal cell carcinoma about the eyelids, which accounts for the rather indolent progress and prolonged duration of many of these lesions. Comparable figures were reported by Driver and Cole,[9] in an analysis of 109 biopsied cases, 73 of which were basal cell carcinomas, 7 cystic basal cell lesions, and 20 cases were squamous cell carcinomas. In a series of 41 cases Regaud and others[31] found only 4 squamous cell carcinomas; Sharp[34] reports 8 squamous cell carcimonas, or about 17 per cent, in a series of 48 neoplasms of the eyelid.

The histogenesis of cancer of the eyelid is discussed in considerable detail by Morax,[24] who concludes that the basal cell carcinomas arise primarily from the meibomian sebaceous glands, and more rarely from the glands of Zeis, along the hair follicles. Small cystic adenomas along the outer aspects of the eyelids are considered to arise from the sweat glands of Moll. The mixed squamous and basal cell carcinomas of the eyelid have interested us, in that they show keratinizing whirls of epithelial cells together with the adenoid arrangement of basal cell lesions. Clinically they have been characterized, in our experience,[17] by unusually rapid growth to large size without metastases; for example, see Cases III and IV.

DISTRIBUTION, EXTENSION AND METASTASES

The regional distribution of cancer of the eyelid shows a remarkable predilection for the medial portion of the lower lid and the area about the inner canthus, about four-fifths of the lesions occurring in this combined area. In our series, 48 per cent occurred along the lower lid and 34 per cent about the inner canthus, with only 6 per cent along the upper lid and 12 per cent adjacent to the outer canthus. Stallard,[36] in a series of 422 cases, reported 193 about the inner canthus, 151 along the lower lid, 59 about the outer canthus, and 19 cases on the upper lid. He emphasizes that lesions about the inner canthus are most resistant to treatment.

Carcinoma of the eyelid extends primarily by direct infiltration. Basal cell carcinoma may extend subcutaneously or permeate locally along adjacent lymphatics, according to Ewing quoted by Robinson,[33] producing what appear to be multiple foci (see Case VI). Basal cell lesions tend to extend subcutaneously and are frequently more extensive than superficial observation might indicate. This subcutaneous permeation explains the recurrences noted after apparently thorough extirpation or circumscribed irradiation of the obvious lesion.

Table II

Histopathology	Lower Lid	Inner Canthus	Upper Lid	Outer Canthus	Total
Basal cell	20	20		8	48
Squamous cell	6	2		2	10
Squamous-basal cell	2	1			3
Keratotic horn					3
Papilloma	1	1	1	1	4
Mole		1	1		2
No biopsy	16	9	4	1	30
Total	48	34	6	12	100

Advancing carcinoma of the eyelid may travel through the lymphatics, penetrate the orbital fascia, and give rise to intra-orbital metastases productive of pain and proptosis, as in Case III. Direct infiltration may invade the conjunctiva and eyeball with ulceration and panophthalmitis. Lesions about the inner canthus tend to invade the lacrimal duct, and on 2 occasions we have seen ulcerative invasion into the ethmoidal sinuses. Inner canthal lesions may spread across the base of the nose to the opposite inner canthus.

Squamous cell carcinoma extends not only by direct infiltration and permeation, as in the case of basal cell carcinoma, but also shows a rather high percentage of metastases to the regional lymph nodes. Two of the 4 cases of squamous cell carcinoma reported by Morax,[24] and 2 of the 10 cases of squamous cell carcinoma in our series developed metastases to the regional lymph

FIG. 1. Case 1. T. C. Bilateral basal cell carcinomata of eyelids, controlled by fractionated roentgen therapy. *A*, November, 1937. Infiltrating carcinoma of right inner canthus treated by 10×520 r in air, 130 kv. (peak), 0.25 mm. Cu, 1 mm. Al filter. Eye shielded. *B*, January, 1945. Right inner canthus healed. Nodular carcinoma at left outer canthus treated by 4×1,320 r, 130 kv. (peak), 1 mm. Al, with eye shielded. *C*, June, 1945. Both eyelids healed, vision clear, some epiphora of right eye.

nodes. The lymphatic drainage of the eyelid is unusually well reviewed by Duke-Elder[10] (see Fig. 2*A*). The superficial lymphatics drain the skin and subcutaneous tissues above the orbicularis, while the deep lymphatics drain the tarsal plates, conjunctiva and regions behind the orbital fascia. Lymphatics communicate through the tarsal plates. These superficial and deep lymphatics from the lateral three-fourths of the upper lid and the lateral aspect of the lower lid drain laterally into the superficial and deep parotid nodes just in front of and below the ear. The metastases noted by Morax were in these nodes and the primary lesions were in the upper lids in both cases. The medial group of lymphatics drain the region of the inner canthus and the medial three-fourths of the lower lid, and follow the course of the facial vein down into the submaxillary group of nodes. In Cases II and III in our series, such metastases have occurred from lesions in the region of the lower lid and the inner canthus. Both the parotid and the submaxillary nodes are drained into the deep cervical nodes near the junction of the common facial and the internal jugular veins. Such extension developed in Case II two years after successful eradication of the carcinoma of the lower lid by roentgen therapy.

EFFECTS OF IRRADIATION ON THE EYE

The literature concerning the action of roentgen rays and radium on the eye was well reviewed by Desjardins[7] in 1931. Our observations show that some edema of the eyelids and conjunctiva may be noted within a few hours, followed by a more or less mucopurulent discharge from the conjunctiva after five to seven days. Conjunctivitis precedes epidermitis of the skin by three to five days. The eyelashes are lost from the irradiated area after ten to twenty days and have not returned in areas successfully treated for cancer of the eyelid. The cornea has shown remarkably little reaction to irradiation. P. Martin[22] describes a loss of lustre through the cornea, with diminution in sensation followed rarely by ulceration three months after intensive radiation therapy. We observed painful ulceration only in Case III, in which the eyeball had been heavily irradiated for retro-orbital extension of recurrent carcinoma three years and again two months previ-

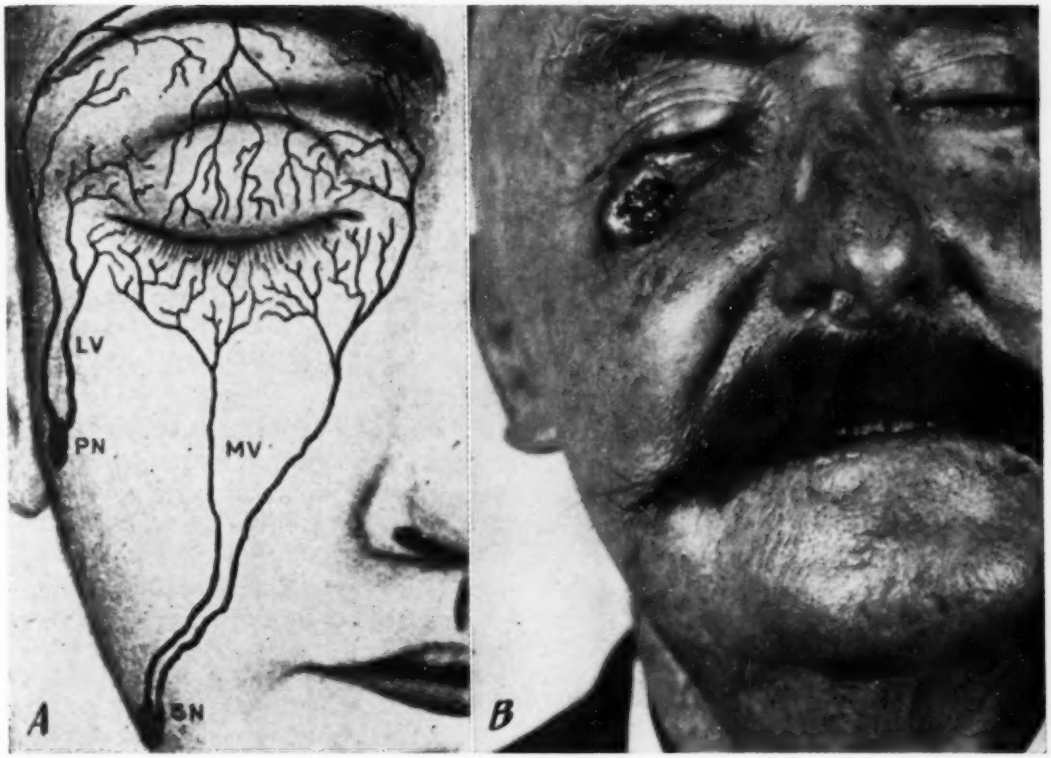

FIG. 2. Case II. H. O. Squamous cell carcinoma of lower lid with subsequent cervical metastases. *A*, Lymphatics of eyelids. *MV*, medial vessels draining into the submaxillary nodes, *SN*; *LV*, lateral vessels draining into the parotid nodes, *PN*. (From Duke-Elder,[10] p. 216.) *B*, ulcerating nodular carcinoma of lower lid cleared by 5 ×900 r in air, 130 kv. (peak), 0.25 mm. Cu, 1 mm. Al. No local recurrence, although deep cervical metastases occurred two years later.

ously without shielding the eyeball. Glaucoma has been reported by Peter[26] following irradiation, but we have recognized no such complication nor is it generally reported. The iris, retina, aqueous and vitreous humors do not appear susceptible to irradiation. Endarteritic changes doubtless occur through the vessels of the choroid and ciliary circulation, although no particular mention is made of such observation. The crystalline lens is very susceptible to injury by irradiation, although a period of three months to twelve years may elapse before cataract becomes apparent.

IRRADIATION CATARACT

The problem of post-irradiation cataract is of such paramount importance to the radiologist in the treatment of cancer of the eyelid by roentgen rays or radium as to warrant special consideration. Anterior polar cataract was observed in irradiated animals by Chalupecky[4] in 1897. The development of a cataract two and a half years following successful eradication of a carcinoma of the eyelid by roentgen irradiation was reported in 1908 by Birch-Hirschfeld.[1] Since that time numerous cases of cataract following both roentgen and radium therapy after intervals of six months to as long as twelve years have been reported. A summary of 34 such cases was prepared by Clapp[5] in 1932, and an excellent review of the literature made. Milner[23] gave an excellent presentation of the clinical aspects of irradiation cataract based on his observation of 13 cases, 3 of which had been treated by radium. Latent periods varied from nine months to twelve years, and averaged about two years. In our

present series of 100 cases, opacities of the lens were noted in 5 cases, latent periods being from six months to eight years. Cases III and IV, as well as a third case, developed cataracts six months, seven years and eight years, respectively, after radium therapy had been applied to carcinomas of the eyelid, face and inner canthus. Two cataracts followed roentgen therapy to the eyelids administered without proper shielding of the eyeball. No opacities of the lens have been observed in any of our private cases of cancer of the eyelid treated by irradiation. The rapidity of onset and degree of opacity of irradiation cataracts depend upon the dosage delivered to the lens and upon the age and general susceptibility of the patient's eye to critical damage. The lens of the fetus and of young animals appears particularly susceptible to injury by irradiation, according to the review by Desjardins.[7] Cataracts produced by roentgen rays and radium appear similar to those resulting from infrared and ultraviolet light,[23] and it is probable that latent injury produced by one agent would be added to that produced by the others. Lenses suffering from incipient cataract due to senility or other cause would be more susceptible to progressive cataract than a normal lens.

The threshold dosage productive of irradiation cataract does not appear to have been established according to the literature, although Stock,[37] and Kumer and Sallmann[18] warn against the delivery of more than an erythema dose of roentgen rays or radium to the eyeball. One of our cases developed a beginning, although definite, cataract five years after delivery of 875 roentgens in air energized by 130 kv. and filtered through 1 mm. of aluminum to a hyperkeratosis on the upper lid, while another patient developed a total cataract within two years following six times 800 roentgens in air of corresponding quality to a lesion on the lower lid. In both cases,

FIG. 3. Case III. H. B. Squamous cell carcinoma of inner canthus with submaxillary metastases; orbital infiltration eight years later. *A*, July, 1934. Squamous cell papule, 6 by 8 mm., beneath spectacle rest with independent large squamobasal lesion of left nasomaxillary sulcus. *B*, October, 1934. Lesions cleared after 5,400 mg-hr. of surface radium, 1 mm. Pt, at 1 cm. Submaxillary metastases resected with no local recurrence. Deep orbital infiltration fatal eleven years later.

cataracts would have been prevented by placement of proper shields over the eyeballs beneath the lids.

In order to compare the cataract threshold dose of radium with that of roentgen rays, it is necessary to translate radium dosage into terms of gamma roentgens delivered to the lens. Milligram-hours equivalent to 1,000 gamma roentgens have been calculated through plotting the area, filtration and distance employed on the charts of Paterson and Parker.[25] For example, in Case IV, radium filtered through 0.5 mm. platinum applied interstitially through an area about 3 by 5 cm. along the lower lid and outer canthus at an estimated distance of 15 mm. from the lens should deliver 1,000 gamma roentgens to the lens for each 800 mg-hr. applied. Since 16.5 mg. was applied for 120 hours, giving 1,980 mg-hr., the dosage to the lens would have been about 2,400 gamma roentgens. This dosage led to a beginning cataract of that eye within six months, which rapidly progressed, while cataract was noted also in the other eye after eight years. In Case III, radium filtered through 1 mm. platinum was applied over an area 5 by 6 cm. on the infra-orbital region by means of a wax mold at a distance of 8 mm. above the skin, although 45 mm. from the lens. In this case 3,600 mg-hr. was considered equivalent to 1,000 gamma roentgens and the dosage of 5,400 mg-hr. delivered about 1,500 gamma roentgens to the lens, which was productive of a cataract after eight years. In the third case treated by radium, incipient changes were noted five years after delivery of about 1,350 gamma roentgens to the lens by a dosage of 960 mg-hr. at the inner canthus. No changes in vision were reported by the patients who received less than the calculated 1,000 gamma roentgens to the lens. Both Blegvad and Milner noted some murkiness of the lens in patients receiving as little as 600 mg-hr. of radium to the eyelids.

Peter has made careful studies of the effect of roentgen rays and gamma rays on the rabbit lens. He reports beginning vacuolations and opacities through the posterior subcortical region five months after delivery of 100 per cent skin erythema dose, (550 r, 150 kv., 3 mm. Al), with similar changes appearing anteriorly ten months following irradiation. A dosage of 200 per cent skin erythema dose (1,100 r in air), produced anterior and posterior cataracts within six months. With larger dosage, cataracts appeared earlier and progressed more rapidly. Peter found that 160 mg-hr. of radium filtered through 0.5 mm. of platinum applied at a distance of 18 mm. produced a fine vacuolation in the lens of a rabbit after five months. According to the charts of Paterson and Parker, about 225 mg-hr. at this filtration, distance and distribution would be equivalent to 1,000 gamma roent-

FIG. 4. Case IV. F. M. Squamobasal carcinoma of eyelids controlled by radium needles. *A*, August, 1935. Polypoid mass invading entire lower and outer third of upper lid, treated by 1,980 mg-hr. radium, interstitially, after surgical ablation. *B*, February, 1936. Neoplasm fully eradicated with remarkable preservation of lids. Cataract left eye six months, both eyes eight years. Died of cerebral hemorrhage, 1944.

FIG. 5. Case v. T. W. Carcinoma of lower lid, controlled by intermediate roentgen therapy. *A*, August, 1931 Infiltrating basal cell plaque in lower lid treated by 5 ×960 r, 130 kv., 0.25 mm. Cu, 1 mm. Al, without eyeshield. *B*, November, 1931. Lesion cleared with good cosmetic result. Cataract of lens within two years; could have been avoided by eyeshield.

gens. A dosage of 640 mg-hr. produced a similar, more rapidly developing and more extensive cataract. Definite opacities in a rabbit's eye are shown by Leinfelder and Kerr[20] six months following exposure to 600 roentgens in air energized by 200 kv. (peak) and filtered through 0.5 mm. of copper. Similar opacities were noted by them twenty-two months after 600 roentgens at one exposure screened by a Thoraeus filter.

There have been two schools of thought regarding the mechanism of irradiation cataract. The direct effect of radiation on the lens has been considered the causative effect by Rohrschneider, Leinfelder and Kerr, and Poppe. Others have maintained that cataract resulted from disturbed nutrition of the lens brought about through effects on the ciliary body and endarteritic changes in the ciliary circulation. This theory has been supported by Milner[23] and by Wölfflin,[40] and at one time was thought by me to be the contributory mechanism, after having observed cataract develop in a lens even though the iris and pupillary region were shielded by a lead screen while treating a conjunctival carcinoma along the limbus. It now appears that the cataract in our case resulted from direct injury to the equatorial epithelial cells and not necessarily from any effect on the ciliary circulation. Goldmann and Liechti[13] likewise found that 2,000 roentgens delivered directly through the center of the lens were unproductive of cataract, while 1,500 roentgens delivered through the equatorial region were productive of cataract. Microscopic observation revealed that the opacities resulted from the generation of shorter and abnormal lens fibers.

It now seems well established that the primary mechanism in the production of irradiation cataract is direct injury to the subcapsular epithelial cells along the anterior aspect of the equator of the lens. Radiosensitivity of these cells probably results from their mitotic activity in the generation of new lens fibers (Duke-Elder).[10] Histopathological studies made by Leinfelder and Kerr[20] revealed that the earliest changes were seen toward the equator of the lens and consisted of degenerative

changes evidenced by vacuolation of cytoplasm in the epithelial cells with gradual extension of pathological changes along the lens fibers into the posterior and anterior subcapsular regions of the lens. These observations were corroborated by Poppe, who noted vacuolation and degenerative changes within twenty-four hours through the so-called middle zone just anterior to the equator with a cessation of mitosis in that area which lasted for six days. Cell outlines became vague, nuclei were pyknotic and chromosomes became fragmented with nuclear disintegration in some cases. After six days abnormal mitoses with binucleated cells and disorderly nuclear patterns appeared which led to the development of swollen and vacuolated lens fibers in the equatorial region with gradual appearance of similar changes in the posterior and anterior subcapsular polar regions.

The ophthalmoscopic appearance of irradiation cataract is rather typical in appearance.[23,28] The findings consist of numerous vacuoles and streaks forming a saucer-shaped opacity densest toward its periphery, located in the axial region of the posterior cortex directly beneath the capsule. A few diffuse vacuoles and striae may be seen beneath the anterior lens capsule, but in early lesions the remainder of the cortex and nucleus are clear. These changes may progress to a total cataract of the lens which is then without characteristic features.

PROTECTIVE EYESHIELDS

Regaud and others[31] in 1926 employed an eyeshield for protection of the eyeball and lens against radiation. Their shield was composed of 2 mm. lead covered on its corneal aspect by rubber. Blegvad[2] noted cataracts following radium therapy, even though an eyeshield of 2 mm. of lead had been used. He felt that an eyeshield 3 mm. thick might adequately protect the eye against gamma radiation, but according to available charts 88 per cent of gamma radiation passes through 2 mm. of lead and 83 per cent through 3 mm. of lead.[12] A lead screen will effectively exclude beta radiation, but could not be made thick enough to exclude more than 20 per cent of the gamma rays. A very effective and satisfactory group of eyeshields* of various sizes developed by Wölfflin[40] has been employed by

* These were formerly procurable from Dr. F. Muller, Weisbaden, Taunusstr. 44, Germany.

Fig. 6. Case vi. J. C. Communicating basal cell carcinomata of lower eyelid controlled by roentgen therapy. *A*, October, 1937. Multiple warty growths on lower lid for seven years. *B*, February, 1938. Lesion cleared and lid healed after 4×1,050 r in air, 140 kv. (peak), 1 mm. Al filter.

Fig. 7. Case vii. C. S. Basal cell carcinoma involving lacrimal ducts, controlled by fractionated superficial roentgen therapy. *A*, March, 1945. Carcinoma of inner canthus with subcutaneous extension treated by 4×1,500 r in air, 80 kv. (peak), no filter, eye shielded. *B*, June, 1945. Lid free of disease, vision clear. Lacrimal duct stenotic with some epiphora.

Fig. 8. Case viii. L. R. Infiltrating squamobasal carcinoma of inner canthus treated by roentgen therapy. *A*, June, 1945. Ulcerating infiltration treated by 5×1,320 r in air, 80 kv. (peak), 1 mm. Al filter. Eye shielded. *B*, October, 1945. Area healed with indeterminate subcutaneous induration treated by 6×800 r, 140 kv. (peak), 0.25 mm. Cu, 1 mm. Al filter. Remains well.

us during the past ten years. The shields are composed of lead, 1.2 mm. in thickness, plated with nickel for absorption of the characteristic radiation of the lead. The sterilized eyeshield is coated with white vaseline before insertion. Wölfflin advocated a coating composed of paraffin 80 per cent, wax 10 per cent, and white vaseline 10 per cent. The conjunctiva is anesthetized by 1 drop of 0.5 per cent pontocaine solution. The patient is asked to look downward while the upper margin of the shield is inserted into the conjunctival sac between the upper lid and eyeball. The patient then rolls the eye upward while the lower lid is drawn downward to enclose the lower border of the shield. Removal of the shield is facilitated by having the patient look upward while the lower margin is extracted above the lower lid, and then look downward as the shield is withdrawn. A comparable protective shield is manufactured in this country.* It differs from the Wölfflin shield in being slightly more shallow and in that it is equipped with a handle on the front surface which facilitates insertion and removal of the shield. Shields of three graduated sizes provide the fullest possible protection, the largest possible shield being introduced in each individual case. Smithers has developed a shield consisting of "perspex," a material used in contact lenses, covered by lead 1 mm. in thickness. Lead shields, 1 mm. thick, absorb 99+ per cent of radiation energized by 80 kv. without filter, and 97+ per cent of radiation energized by 140 kv. filtered through 0.25 mm. copper and 1 mm. aluminum, according to our measurements. It is important that there be no irregularities or projections along the posterior aspect of a protective eyeshield, since corneal abrasions so produced give a sensation of foreign body and may result in a troublesome keratitis.

FIG. 9. Case IX. L. A. Small basal cell carcinoma controlled by single superficial roentgen treatment. *A*, May, 1944. Nodular lesion treated by 4,800 r in air, 80 kv. (peak), no filter. Eye shielded. *B*, June, 1946. Lesion eradicated, eyelid healed, vision clear.

* By Mager and Gougelman, 30 North Michigan Avenue, Chicago, Illinois.

AVOIDANCE AND TREATMENT OF CATARACT

The development of a cataract of the lens subsequent to irradiation for cancer of the

FIG. 10. Case X. E. G. Cystic basal cell carcinoma removed by fractionated superficial roentgen therapy. *A*, August, 1939. Thick nodule on lower lid, 6 × 1,200 r, 80 kv. (peak), no filter, plus 2,500 r, four weeks later. *B*, December, 1939. Slow gradual regression of lesion with good functional and cosmetic result.

eyelid should be encountered very rarely when the therapist employs precautions available in the light of present knowledge. In the treatment of cancer of the eyelid, the primary roentgen-ray beam should never be directed toward the eyeball without the prior insertion of an effective eyeshield beneath the lid. The peripheral margins of the treated area should be carefully delimited by an individually fashioned lead foil stencil in order to avoid unnecessary exposure to the adjacent healthy tissues and to minimize scattering of radiation into the lens. Scattering of radiation increases with enlargement of the area and with elevation of voltage.[16] In the case of fields 4 cm. or larger in size and voltages above 100,000, 10 per cent or more of the primary dose may be scattered into the sides and back of the eyeball from about the eyeshield. The penetration should be kept low by the employment of voltages of 50 to 90 kv. (peak) with no filter, or at the most 1 mm. of aluminum, for superficial lesions limited to the lid. Higher voltage and more filtration is warranted in the treatment of carcinomas which are infiltrating the orbit or structures about the inner canthus. Depth dosage can be further reduced through application of roentgen therapy at distances below 15 cm., which is practical with the present superficial or intermediate roentgen therapy tube. In the treatment of large bulky carcinomas about the eye, surgical ablation of the protruding mass is indicated prior to application of radiation.[17] Elimination of this thick layer of tissue reduces the total dosage which must be administered and makes possible the employment of rays of less penetration, thereby reducing depth dosage and minimizing irradiation of the eyeball. In Case IV, irradiation cataract resulted in spite of surgical resection of the polypoid mass prior to implantation of radium needles. In retrospect, we are certain that irradiation of the lens could have been definitely reduced in this case and cataract would probably have been avoided through application of superficial roentgen therapy while the eyeball was effectively shielded. Roentgen therapy, when applied with proper shielding of the eyeball, carries definitely less hazard of irradiation cataract than does radium therapy. On the other hand, radium therapy has been far less productive of cataracts than roentgen therapy improperly applied without protection of the lens by an eyeshield.

Loss of vision due to irradiation cataract can be remedied by performance of an intracapsular extraction of the lens and fitting of proper glasses. Reese[29] has reported successful operation on 25 patients among 112 cases of irradiation cataract seen at the Memorial Hospital. He emphasizes that intracapsular extraction is the most suitable form of treatment and that extracapsular extraction is contraindicated in such cases.

Loss of vision due to irradiation cataract has been restored in one of our cases by extraction of the lens and fitting of proper glasses by a skilled oculist.

TREATMENT

The primary consideration in the treatment of cancer is the complete and most certain eradication of the disease. It is important that this be accomplished with as little interference with function, with a minimum of deformity, and with as little injury to the uninvolved and surrounding tissues as is consistent with control of the disease. In cancer of the eyelid, it is desirable to preserve the lid as far as possible in order to minimize deformity, as well as to insure proper retention of tears and protective bathing of the eyeball. Ectropion, entropion and trichiasis are all harmful to the cornea. Closure of the lacrimal duct is to be avoided, if possible, in order to permit the proper drainage of tears from the conjunctival sac with prevention of epiphora. The lens must be safeguarded against irradiation, as far as possible, in order to avoid a premature development of opacities. Injury to the cornea and eyeball in general whether by irradiation, cautery, puncture or abrasion is to be avoided.

The treatment applied in our series of 100 cases varied in type and combination according to the individual problem, and according to our maturity of experience at the time. Roentgen therapy was employed in 92 cases, radium therapy in 11 cases, and electrosurgical procedures in 12 cases. Further analysis shows that roentgen therapy alone was employed in 80 cases, radium alone in 3 cases, radium and roentgen rays combined in 5 cases, electrosurgery and roentgen rays in 7 cases, electrosurgery and radium in 3 cases and electrosurgery alone in 2 cases (Table III).

It is difficult to make a statistical evaluation of the relative merits of these various types or combinations of treatment since the difficulties presented varied widely between the different groups of cases. The curability of early cancer of the eyelid is very high by any one of these methods properly employed. Advanced cancer of the eyelid presents serious problems, disastrous complications and not infrequently results fatally, as in Cases II and III, regardless of the type of therapy.

RADIOTHERAPY

Progress made in the radiotherapeutic treatment of cancer of the eyelid is well illustrated by comparison of the reports from

TABLE III

THERAPEUTIC METHODS USED IN NEOPLASMS OF EYELID

Methods	Cases	Roentgen rays	Radium	Electrosurgery
Roentgen rays alone	80	80		
Roentgen rays and electrosurgery	7	7		7
Radium and roentgen rays	5	5	5	
Radium alone	3		3	
Radium and electrosurgery	3		3	3
Electrosurgery alone	2			2
Total	100	92	11	12

the Radium Institute of Paris in the year 1926 and in 1939. In 1926, Regaud and others[31] reported five year cures in 84 per cent of operable cases, in 66.6 per cent of borderline cases, and in 50 per cent of inoperable cases. In 1939, Dollfus[8] reported only 2 recurrences among 100 cases treated from 1935 to 1937.

Radiation therapy is particularly well adapted to treatment of nodular and infiltrating carcinomas of the eyelid since it is possible thereby to eradicate the carcinoma and yet preserve the basic lid structure insofar as it has not been destroyed or replaced by cancer. Radium therapy was preferred by us prior to 1936 due to more reliable eradication of the cancer with good cosmetic results. Roentgen therapy equipment was cumbersome, poorly protected, and

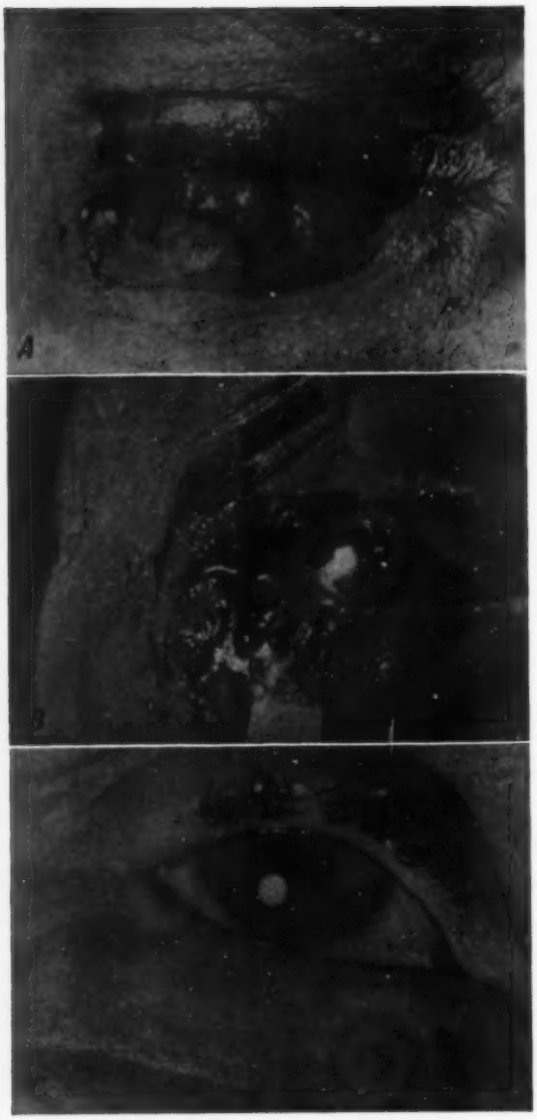

Fig. 11. Case xi. E. H. Extensive basal cell carcinoma of outer canthus successfully treated by roentgen therapy. *A*, October, 1944. Infiltrating induration of lower lid and outer canthus. *B*, lesion treated by 2×2,200 r in air, 140 kv. (peak), no filter. Eyeshield beneath lids. *C*, December, 1944. Carcinoma is controlled, lid healed and well preserved.

final results from roentgen therapy were still somewhat undisclosed. Roentgen therapy has now become our radiotherapeutic method of choice due to its proved effectiveness, accuracy, simplicity and restriction of exposure more closely to the diseased area. The scars from roentgen therapy may be slightly more apparent due to their sharper delimitation, but this can be reduced by multiple exposures and through the use of fenestrated screens of slightly varied size and shape. The feasibility of more adequate protection of the lens against roentgen rays than against gamma rays has already been discussed at some length. Roentgen therapy is advantageous, as pointed out by Regaud and others,[31] and Widmann[39] in the treatment of lesions which cover large surfaces and in lesions showing deep infiltrations of the orbital or medial canthal structures.

The technical factors currently employed by us in roentgen therapy to cancer of the eyelid vary with the thickness and extent of the lesion. Our observations have led us to believe that scars are less atrophic, more pliable and durable in those cases to whom fractionated dosage has been given in contrast to a single massive dose, even though the neoplasm can be effectively eradicated by either the massive dose or fractionated dosage. In the case of lesions over 5 mm. in size, fractionation is desirable. The larger the lesion in extent, the more advisable fractionation becomes in order to preserve the health and nutrition of the tumor bed. Fractionation is also advantageous in lesions over 3 or 4 mm. in thickness, since shrinkage of the tumor following initial exposures permits more effective exposure of the base of the cancer, with relatively less irradiation of underlying tissues.

Inasmuch as roentgen dosage on small lesions is usually recorded in air without backscattering, it is essential to bear in mind that air dosage must be increased about 10 to 50 per cent when dealing with lesions less than 10 to 5 mm. in size in order to deliver dosage comparable to that developed in a lesion 20 to 30 mm. in size. Roentgen radiation energized by 70 kv. (peak) and without the employment of additional filtration is usually sufficient for eradication of the smaller and more superficial carcinomas of the eyelid. Lesions over 3 to 4 mm. in thickness warrant 90 kv.

(peak) with or without 1 mm. of aluminum filtration. The more infiltrating lesions of the eyelids have been treated by 130 kv. (peak) radiation filtered through 0.25 mm. of copper and 1 mm. of aluminum. Deep infiltrations of the orbit have been treated by 200 kv. (peak) filtered through 0.5 mm. copper or Thoraeus filter.

In those cases where a single roentgen treatment was employed, an average dosage of 2,875 roentgens in air was found effective. Recurrences have been occasionally noted in dosages below this level, when employing 70 kv. (peak) and no filter. Treatments during the past six years have been applied with a Thermax tube, the wall of which has a filtration equivalent to 0.5 mm. aluminum. An average dosage of 3,400 to 4,200 roentgens in air was employed when two treatments were delivered within a period of two to seven days. A total dosage of 4,000 to 5,400 roentgens in air was employed when three treatments were delivered within a period of three to fourteen days. A total dosage of 5,000 to 8,500 roentgens was employed if five or more equal treatments were delivered during a period of five to twenty-one days. In general, the smaller the area and the longer the interval between treatments, the larger the total dosage given.

The effectiveness of roentgen therapy in the treatment of cancer of the eyelid is illustrated by Cases 1 and v to xii, inclusive. The dosage employed must be sufficiently high to eradicate cancer and prevent recurrence. On the other hand, scarring, deformity and tissue impairment increase with the higher total dosage. Deformity depends largely on the extent of the lesion and the degree to which tissues have been destroyed or replaced by cancer prior to treatment. It is essential that the irradiation be carried 3 mm. or more beyond the obvious border of the lesion. The margin is determined by careful palpation and inspection through a binocular loupe. Insufficient coverage will invariably lead to marginal recurrence. Atrophy, telangiectasia and post-irradiation ulceration are much more prone to occur whenever a second course of treatment is necessitated.

Fig. 12. Case xii. M. H. Basal cell carcinoma replacing upper lid, controlled by roentgen therapy, residual deformity warrants plastic repair. *A*, October, 1944. Extensive invasion of inner canthus and medial aspect of right upper lid. Bilateral senile cataracts. *B*, June, 1946. Cancer controlled by 12×750 r, 90 kv. (peak), 1 mm. Al in twenty-six days, eye shielded. Defect of lid due to destruction by cancer.

Short distance, low voltage, so-called contact roentgen therapy has been advocated by Smithers,[35] Hollander and Krugh,[15] Bullo,[3] and others, in the treatment of the eyelids and conjunctiva. The advantages claimed over ordinary roentgen irradiation are the reduced penetration to underlying tissues and the shorter time required for administration of therapy. It is essential, however, that eyeshields be used in association with either the Philips or Chaoul units. Bullo has calculated the depth dose at the lens to be 59 per cent of the surface dose at the cornea, using a Chaoul unit operated at 50 to 60 kv., filtration 0.2 mm.

copper, distance 5 cm. These short distance roentgen-ray units provide the rapid decrease of intensity in the depth of the tissues made possible with radium and yet maintain the advantage of better marginal confinement of therapy permitted with roentgen radiation. This method has the further advantage over radium that a leaded eye screen will completely protect the lens against all primary radiation. These main advantages can be effectively approximated by an ordinary roentgen therapy machine operating at 60 kv. (peak), employing a shockproof tube without filter at a distance of 15 cm. or less.

In the present series, 11 cases were treated by radium, of which 8 were by surface application, 2 by combined surface and interstitial, and 1 by interstitial radium alone. Two cases died from cancer five and eight years after radium. In Case III the primary lesion was controlled, but a recurrent infiltration developed in the orbit eight years later which was eventually fatal. A patient previously treated by radium elsewhere for an advanced cancer of the inner canthus with invasion of the eyeball and ethmoidal sinuses died from recurrence five years after enucleation and combined radium treatment here. Richards reported only 3 failures in a group of 100 cases treated by radium needles and by surface applicators. Richards[32] and Robinson[33] both favor interstitial radium since it is thereby possible to deliver a maximum dosage to the disease with the least irradiation of the eyeball. Sharp favors a combined application, about one-third interstitial and two-thirds on the surface.

Radium needles are to be used with caution about the inner canthus for fear of stenosis of the lacrimal ducts. We see no particular advantage in surface application of radium over roentgen therapy. We do feel that interstitial radium still has some merit in individual cases which show persistent or recurrent cancer after roentgen therapy and in the case of orbital infiltration or recurrence. Interstital radium has been applied with good success by us according to the low intensity, 0.5 mm. platinum technique of Cade as popularized in this country by C. L. Martin.[21] The dosages of radium employed have been estimated to deliver about 7 to 10 erythema doses as computed from the charts of Quimby,[12] and about 7,000 gamma roentgens from those of Paterson and Parker.[25] Cataract was noted in 3 of our 11 radium cases, probably due to the large total dosage required in Cases III and IV, as already discussed under the heading of "Irradiation Cataract." Richards observed 2 cases of irradiation cataract while Robinson, Driver and Cole, and Sharp report no cataracts evident at the time their papers were prepared. More or less irradiation of the lens is unavoidable with radium therapy, and this is its primary disadvantage.

SURGICAL TREATMENT

Surgical resection is advocated as the treatment of choice by Hollander and Krugh, and is doubtless employed by some other ophthalmologists who are particularly skillful in plastic repair of the eyelid. Recurrence peripheral to the line of excision is not infrequent following surgical resection, as pointed out by Robinson, due to the effort of the surgeon to conserve as much of the lid as possible and the not infrequent subcutaneous extension of basal cell carcinoma beyond the obvious involvement of the epidermis. Plastic repair is said to be particularly difficult in those cases which require excision of a portion of the tarsal plate.

Destruction of carcinoma by fulguration plays a highly important rôle in the treatment of neoplasms of the eyelid. It is currently employed by us in the treatment of small papillary lesions preliminary to irradiation of the base with superficial roentgen irradiation. Benign nevi and small papillomas can be effectively destroyed by fulguration alone. The successful application of fulguration and electrocoagulation as a complete therapeutic procedure involves not only desiccation of the lesion, but, equally important, the thorough re-

moval of the burned tissue and continued refulguration until all carcinoma or neoplastic tissue has been removed. As viewed through the binocular loupe, the remnant of neoplasm will show a small, friable, bleeding area, whereas, after elimination of all neoplasm, the field remains dry, soft and elastic in consistency. If the lesion is simply excised as a biopsy and the base fulgurated for control of bleeding, it is most assuredly necessary to thoroughly irradiate the base and the area for about 3 mm. surrounding it for control of the disease.

The pre-irradiation ablation of large tumors, as in Case IV, facilitates treatment, shortens the period of convalescence and healing, and decreases the irradiation of the lens and other adjacent tissues. One should be careful not to excise a neoplasm below the level of normal contour of tissues, nor in fact, quite down to the general contour. The function of such a surgical ablation is entirely one of making the base of the tumor directly accessible to superficial roentgen treatment.

Post-irradiation surgical repair has a definite place in cancer therapy. The ulcerating lesion of the eyelid, which has created a large defect without much surrounding infiltration, may as well be excised originally and a plastic repair done at that time. Deformity following eradication of cancer by irradiation may be such as to warrant a sliding flap or a plastic lengthening of the lid in the correction of lid deformities, as in Case XII. If tissue breakdown occurs as a result of avascularization and sequestration of tissue following irradiation, surgical resection with a plastic repair by a split graft or a sliding flap may be indicated. In general, we have seen little difficulty with post-irradiation breakdown on the eyelids. Even though the enclosed tarsal plates are composed of cartilage, post-irradiation chondritis in the lids is remarkably rare. Dilatation of the stenosed lacrimal duct may at times be of some help if it has become narrowed from constriction by invading neoplasm or post-irradiation scar tissue, as in Case VII. Surgical removal of irradiation cataracts for restoration of vision has already been discussed.

Cancers of the eyelid associated with invasion of the bulbar conjunctiva and eyeball should be treated by surgical removal of the eyeball followed by thorough irradiation of the orbital soft tissues. Thorough irradiation of such an eye is bound to lead to lens opacity within a period of a few months or years. The associated conjunctivitis, ulceration and pain in a retained eye is, as a rule, much more troublesome to the patient than is the surgical removal of the eyeball. Following exenteration or enucleation, the orbit can be irradiated by superficial placement of multiple radium tubes or implantation of radium needles through the remaining carcinoma. Deep roentgen therapy is effective, but has the handicap of more irradiation of the underlying tissues and bones with the possibility of subsequent osteomyelitis and sequestration of bone months or years later.

Squamous cell carcinoma of the eyelids is prone to metastasize to the parotid or submaxillary gland and deep cervical nodes. Stout[38] advocates surgical removal of the appropriate regional nodes in the treatment of cancer of the eyelid. This operation was done in Case III with very great benefit to the patient. If the deep cervical nodes, as well as the submaxillary or parotid nodes, are enlarged, deep roentgen therapy and implantation of long 2 mg. radium needles is justified in the light of our experience with metastatic cervical cancer from the lip.

ANALYSIS OF RESULTS

A detailed follow-up analysis of our results in the treatment of cancer of the eyelid is not fully reliable, since many in the sixty to ninety year age group have died from other causes since treatment was given. The follow-up of clinic patients proves particularly difficult. So far as we know, there has been only one failure to control the cancer in the group of 41 private patients; this patient failed to return for completion of a roentgen irradiation series due to the advent of cerebral thrombosis.

Among the clinic group, 4 have died from cancer of the eyelid.

The first fatal case, seen in 1930, presented a flat squamous cell carcinoma of the lower lid and cheek, 5 cm. in size, previously irradiated. Further inadequate roentgen irradiation was given, followed by electrosurgical resection and plastic repair with subsequent recurrence. The second fatal case, seen in 1931, has been discussed under "Radium Therapy." The other 2 fatalities are Cases II and III reported in this paper. In general, the poorer results observed in the clinic patients are due to the more advanced stages of their disease. There were no cataracts observed in the group of private patients treated, while 5 cataracts were observed among the clinic patients due to the larger radium dosages required and less complete supervision of their roentgen treatment.

An analysis of the causes for failure in the treatment of cancer of the eyelid might be broken down into the following: (1) Advanced stage of the disease, such as invasion of the orbit, invasion of the eyeball, invasion of the lacrimal duct and ethmoidal sinuses, and metastases to the submaxillary or parotid lymph glands. (2) Inadequate treatment: (*a*) inadequate coverage with failure to treat beyond the infiltrating margin of the neoplasm being the most common cause of failure in roentgen therapy; (*b*) inadequate dosage from too low total dosage or from inadequate penetration to deliver sufficient dosage to the base of the tumor; (*c*) associated patches of under and over dosage due to improper distribution of radium applicators. (3) Impairment of tissues by previous inadequate treatment with resulting reduction of vascularity and lowering of tolerance of tumor bed to further irradiation or surgery. (4) Failure of patients to return for treatment and follow-up examination due to illness, lack of understanding or poor cooperation. (5) Complications from treatment, such as irradiation cataract, deformity of lids, stenosis of the lacrimal duct, or ulceration of the cornea.

SUMMARY AND CONCLUSIONS

1. Carcinoma of the eyelid is a disease of the elder age group primarily, three-fourths of the patients being past sixty years of age. Men are slightly more susceptible to cancer of the eyelid than women.

2. Four-fifths of the lesions are located along the lower lid or about the inner canthus.

3. Basal cell carcinomas represent three-fourths of the neoplasms of the eyelid and these lesions usually show slow growth, giving an antecedent history of one to three years or more.

4. Squamous cell carcinoma of the eyelid, although not common, is a more serious lesion, shows greater local invasion and frequently metastasizes to the parotid or submaxillary glands.

5. Cancer of the eyelid can be as effectively controlled by fractionated roentgen therapy as by surface radium and with less irradiation of the eyeball in case an eyeshield is employed.

6. The rôle of interstitial radium appears limited to recurrent or persistent subcutaneous lesions, to intra-orbital or other deep infiltrations, and to non-resectable metastatic regional nodes.

7. The threshold dose of radiation productive of lenticular opacities appears to be about one skin unit. Cataract has been clinically observed five years after delivery of 775 tissue roentgens (about 1.5 unit skin doses at 130 kv. (peak)), to the lens and seven years after delivery of about 1,000 gamma roentgens to the lens. Cataracts may appear from six months to eight and more years after irradiation.

8. The eyeball and lens can be effectively protected against superficial roentgen rays and beta rays by an eyeshield equivalent to 1 mm. of lead. No eyeshield is adequate for protection against the more penetrating gamma rays.

9. Irradiation of the lens can be minimized by (*a*) employment of an eyeshield whenever roentgen therapy is applied about the eye; (*b*) use of lowest voltage, least filtration and shortest distance compatible

with adequate and homogeneous irradiation of the disease; (*c*) replacement of teleradium and surface radium therapy with appropriate roentgen therapy, and (*d*) application of filtered radium interstitially and limitation of its use to lesions more or less refractory or inaccessible to roentgen irradiation.

10. Meticulous fulguration is the treatment of choice in the removal of benign moles and papillomas.

11. Surgical ablation of large elevated carcinomas of the eyelid prior to roentgen therapy permits more effective treatment of their base with less mass irradiation of the eyeball and other adjacent non-diseased tissues by both primary and scattered rays.

12. Post-irradiation surgery is indicated only rarely for closure of defects, correction of contracting deformities, dilation of stenotic lacrimal ducts, extraction of a now very rare cataract. Localized adenopathy warrants resection.

13. Four of the one hundred cases reviewed have died from cancer of the eyelid during the past fifteen years. Therapeutic failures result from (*a*) advanced and inaccessible disease; (*b*) impairment of tumor bed by prior inadequate therapy; (*c*) insufficient or uneven dosage; (*d*) incomplete marginal coverage of lesion, and (*e*) inadequate follow-up of patients.

14. In general, superficial roentgen therapy is very effective in eradication of cancer of the eyelid with maximal preservation of the uninvolved tissues and with minimal injury to the eye when properly protected by an eyeshield.*

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CANCER OF THE TONGUE*

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CANCER of the tongue is a major challenge to the cancer surgeon. Although the tongue appears to be a relatively acessible organ, neoplasms in this location present many baffling aspects. Histopathology as well as the clinical course tends to be more diversified in lingual growths than in other oral tumors. Metastases occur early and require a different plan of treatment than the primary growth. Consequently, the therapist must be equally adept in the use of roentgen radiation, radium and surgery in order to cope with the many complications which may develop during the treatment period. These numerous difficulties were first pointed out by Quick[11] who proceeded to establish many irradiation principles for the control of primary lesion and cervical metastatic involvement.

It is the purpose of this paper to present a flexible plan which has proved satisfactory. While in other reports the eradication of the lesion was often followed by necrosis and other tissue damage, complications rarely occurred among the cases treated in this manner.

The following presentation is based on the records of 81 cases, 27 of which were treated in private practice, while 54 were patients of the Veterans Administration Facility, Los Angeles, California. As these two groups show distinct divergencies in several respects, it seemed advisable to review them separately.

In both groups, the case material represents an unselected, consecutive series of all patients with cancer of the tongue treated during the years 1932 to 1940, and including the admissions during the first six months of 1941. No selection was made, and patients with symptoms of only a few weeks' standing, as well as recurrent and terminal cases (and several previously treated) have been included in the present series.

Among the group of patients treated in private practice (in the following called Group A), 70.8 per cent were male. Martin, Munster and Sugarbaker[6] report from their larger series an incidence of 87 per cent males, while Simpson[15] found 79.5 per cent of males among his patients, and Richards[14] encountered 80 per cent males. The cases from the Veterans Administration Facility (in the following called Group B) were all males.

Age. In Group A, representing a cross section of an average population, the mean age of patients at time of admission was 62.2 years; the youngest patient was thirty years of age, the oldest eighty-one. Sixty and eight-tenths per cent of all cases occurred between the ages of sixty and seventy-nine years. In Group B, from the Veterans Hospital, the average age at time of admission was 55.8 years; the youngest patient was thirty-seven, the oldest ninety years of age. Twenty-nine and six-tenths per cent of the cases occurred in the sixty to sixty-nine year bracket, more than in any other decade; 83.3 per cent of all patients were between forty and sixty-nine years of age.

Etiology. Among the causes of cancer of the tongue, chronic irritation seems to occur most frequently. It can generally be traced back to excessive use of tobacco, to various dental factors, and to a lack of oral hygiene.

Excessive smoking was encountered in about one-third of all cases. Tobacco acts

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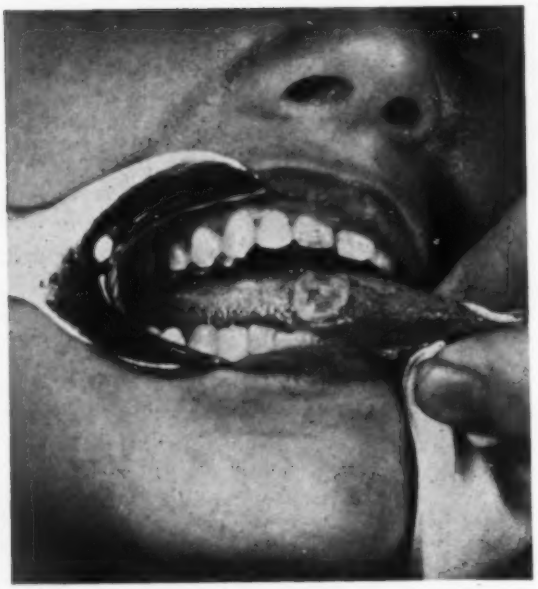

Fig. 1. Precancerous benign lesion with overgrowth, due to jagged tooth.

mainly as a chemical and thermal irritant; but a similar effect may also be caused by habitual ingestion of excessively hot beverages and soups, highly seasoned foods, and strong mouth washes.

Various dental factors are probably more directly responsible for lingual carcinoma than any other single cause. Jagged, broken worn, or rough teeth may result in trauma to the tongue by tearing or eroding its borders (Fig. 1).

It is very significant, in this respect, that primary lesions along the two borders have been very frequent in all reports, and half the cases in one group of our series were of this kind. In a similar manner, the gap between two normal teeth may prove to be an abnormal irritant. A smooth, but malposed tooth may lead to biting of the tongue which in turn may result in malignant growth. Cases have been reported where an incident of this kind led to a course of disease ending lethally within much less than one year's time.

In a number of instances, dental plates have been noted as the cause of lingual carcinoma. Ill fitting or rough dentures may rub and erode the mucous membrane; but even in cases where no irritation is produced mechanically, the plate material may contain chemical irritants, such as arsenic, fluorine, or specific coal tar dyes which will irritate sensitive mucous membranes.

Sometimes, cancer of the tongue can be traced back to tonsillitis of many years' standing. The relation of lingual carcinoma to syphilis will be discussed in a later section. A rare instance of traumatic origin occurred in the history of one of our patients: he scratched his tongue on a nail; the lesion led to ulceration of the tip of the tongue, which had turned into carcinoma and involved the cervical nodes before medical advice was sought.

Etiologic factors or stimuli of this kind produce cancer of the tongue only under certain conditions, but little is known at the present time about such a diathesis which, nevertheless, we are forced to assume.

Precancerous Lesions. Precancerous lesions are not the "cause" of cancer. The term connctes merely the existence of certain abnormal conditions under which cancer is likely to occur or under which such a course will occur in a fair percentage of cases. By early recognition of these precancerous lesions and institution of proper treatment the development of lingual cancer could be prevented in 50 to 75 per cent of all cases. Such precancerous conditions include papilloma, fissure of the tongue, burns, scars left after infectious invasion, and lingual hypersensibility. Leukoplakia is the most common precursor of lingual carcinoma (Fig. 2). While leukoplakia is formally accepted as one of the principal causes, the connection between these two morbid processes seems to be more complex than has often been assumed. Singly or concurrently either leukoplakia or cancer may be stimulated in a patient by the same etiological factors (Fig. 3).

The presence of leukoplakia concomitant with lingual carcinoma was found to favor successful treatment. When cancer is superimposed upon leukoplakia, it is usually of slow growth; biopsy will generally demonstrate a low degree of malignancy, and the

tendency to invade adjacent tissues or to metastasize to cervical nodes is less pronounced. In Group A leukoplakia was noted in 40.7 per cent of all cases, and in Group B in 37.5 per cent.

The important rôle of pyorrhea and advanced dental caries has been recognized throughout the literature on cancer of the tongue. "The bacterial flora of the ill-kept mouth exerts a profound influence on the otherwise normal course of a growth, if indeed, it does not actually contribute towards its development."[11] It is gratifying that through the introduction of penicillin, pyorrhea and other infectious conditions of the oral cavity can now be much more readily controlled.

Symptomatology. Epidermoid carcinoma begins almost always as an overgrowth. This process of morbid hypertrophy may be of a primary or a secondary character, or may arise on the basis of pre-existing leukoplakia. During its initial period, such an overgrowth fails to produce symptoms of any kind and therefore generally remains undetected. Not until somewhat later does ulceration develop, usually in the form of a fissure; at that time, soreness and pain will appear to varying degrees. But whether erosion or ulceration of the mucosa takes place at an early date, or later in the course of the disease, depends wholly upon the nature of the trauma, the violence of the infection, and the degree of malignancy.

FIG. 2. Benign papilloma showing precancerous leukoplakic changes due to dental irritation.

FIG. 3. Carcinomatous changes of squamous cell type, developing in minute area of leukoplakia.

In its early stages, cancer of the tongue will follow more or less closely one of a number of characteristic developments. The lesion may start on the surface, but for months the progress will be so slow that only minor change, mostly in the form of a superficial ulcer, becomes visible. A tumor following this course will remain local zed for an appreciable period of time. In other cases, lesions may invade downward to form an indurated mass, and ulceration will develop only later. Carcinomatous ulcers may become secondarily infected at any time and cause extensive infiltration, excavation, and intense local and radiating pain. Highly inflamed growths of this type are locally aggressive, and metastases are the rule. Still another course is characterized by moderate local growth, and early massive metastases to the cervical nodes. In cases of this kind, an enlarged node in the neck may constitute the first warning, while the primary growth may be difficult to detect. Finally, the growths arising on the dorsum

of the tongue may pass through a preeruptive stage with deep infiltration of the body of the tongue, and little or no surface ulceration.

A disease process entailing the possibility of so many different developments will produce, upon first examination, one of a variety of typical appearances, depending upon speed of growth, virulence of infection, and subsequent complications. But, as far as it is possible to speak of a characteristic picture of cancer of the tongue, it can be described as a crateriform ulcer, with rolled edges, forming an indurated mass.

TABLE I

FIVE YEAR CURES RELATED TO DURATION OF SYMPTOMS AT TIME OF EXAMINATION

Group A: 27 Cases from Private Practice

	Symptoms Lasting less than Two Months	Symptoms Lasting Two Months to One Year	Symptoms Lasting One Year and More
Total number of cases	6	18	3
Number of five year cures	4	3	0
Percentage of five year cures	66.6%	16.6%	0.0%

Ulcerous lesions are not necessarily malignant, and ulcerations may be produced by benign tumors and by different types of mucosal infection. But it cannot be stressed strongly enough that whenever a persistent ulcer, a chronic fissure of the tongue, an indurated epithelial wart, or a case of advanced leukoplakia is encountered, cancer should always be suspected. Lingual carcinoma is frequently characterized by rapid onset of infiltration and metastasis—even in its early stages. Therefore, no time should be lost and a biopsy should be performed immediately in all cases, as the absence of cancer cannot be proved by any other procedure.

As it is impossible to arrive at a definite diagnosis on the basis of primary symptoms, the secondary signs may assume increased importance. If inspection of the neck reveals indurated nodes, this finding, in combination with a primary lesion of the tongue must in almost all cases be considered indicative of the presence of an aggressive type of malignant growth, requiring immediate therapy. Pain, on the other hand, is a sign of only limited diagnostic value. Pain may appear early in the process, or not until later; it may be local or radiating to other areas; it may be an acute, topical sensation limited to the region of the growth, or an indirect result of restricted mobility of the tongue. Pain produced by deglutition may be an early indication of a lesion at the juncture of the root of the tongue with the anterior tonsillar pillars; it may be symptomatic of an advanced growth in the region of the base of the tongue, or caused by secondary invasion of subglottic tissues. Only in one instance can pain be considered as pathognomonic: when the sensation of pain is no longer localized, but radiates into other parts, especially to the ear and the temporal regions, the disease must be considered to have invaded cranial nerves, and an advanced growth must be assumed.

Duration of Symptoms at Time of Examination. As in many cases cancer of the tongue assumes a rapid development, early diagnosis and immediate treatment must be considered as essential. Yet, the absence of pain in many instances as well as the limited size of the lesion, and the nonspecific appearance of the initial overgrowth tend to delay timely discovery. Thus, the duration of symptoms prior to examination of the patient assumes considerable importance.

In Group A of our series, the average duration of symptoms was 7.6 months—the longest being two years, the shortest two weeks; in Group B the mean was 8.5 months, while the extremes were three years, and one month, respectively. The averages in both groups do not differ materially from the figure given by Martin

et al.,[6] ("about seven months") while Cade[2] reports a much shorter duration (four months).

The importance of early recognition of lingual carcinoma for the successful outcome of treatment can be clearly seen when the average duration of symptoms before examination in *all cases* of Group A (7.6 months) is contrasted with the average duration for *successful five year cures* (3.97 months). Still more significant is a comparison of the rate of five year survivals if the cases are divided into three classes: the cases which were seen less than two months following the onset of symptoms; after a duration of between two months and one year; and finally those with symptoms which had lasted for more than one year (Table 1).

Classification of Lesions. A classification of lingual cancer has been proposed by several authors, but still no system has been universally accepted which will permit a comparison of results as for instance in the case of cervical and breast cancer. Martin *et al.*,[6] suggest the addition of a new intermediate group of "borderline" cases in order to amplify the old classification into "operable" and "inoperable" cases, which originated at the time when surgery was still prevalent in the therapy of the primary lesion. Richards[14] proposed an entirely different approach by introducing a two-fold grouping of each case; first, according to the size of the lesion, and second, by the status of secondary involvement.

In order to assist in the determination of the prognosis and in the choice of the best possible plan of treatment, a classification should indicate at the same time the condition of the primary lesion and that of any secondary involvement. We have, therefore, grouped our patients by stages:

Stage I: a primary growth of less than 1.5 cm. in diameter (Fig. 4).
Stage II: a primary growth of less than 3 cm. in diameter (Fig. 5).

Stage III: a primary growth of indeterminate size, but with unilateral involvement of cervical nodes, permitting surgical removal (Fig. 6).

Stage IV: a primary growth with invasion

Fig. 4. Stage I: Primary growth less than 1.5 cm. in diameter, on the tip of the tongue.

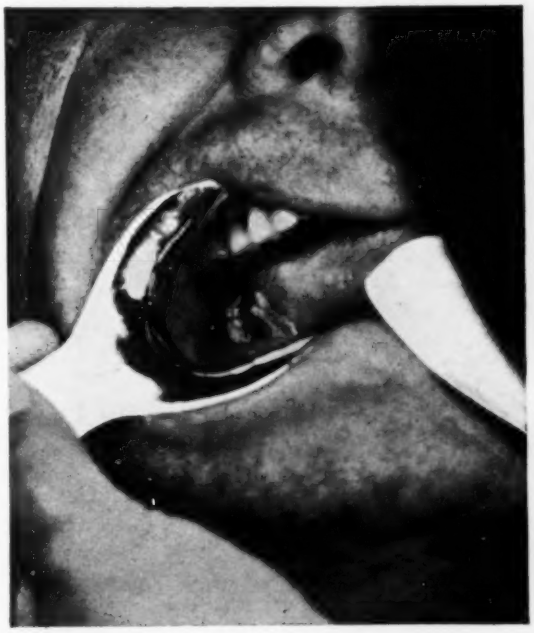

Fig. 5. Stage II: Primary growth less than 3.0 cm. in diameter, on the border of the tongue.

of surrounding structures and inoperable cervical metastases (Table II).

From Table II it can be seen that only 28.4 per cent of the cases were examined

FIG. 6. Stage III: Primary growth greater than 3.0 cm. in diameter, with unilateral cervical metastasis. This patient is well, seven years after radical neck dissection.

while the disease was in its early stages. The percentage of Stage I and II in the private cases (Group A) is considerably higher (37 per cent) than in the veteran cases (Group B) (24 per cent). The ratio of five year cures in the combined Stages I and II was 52.2 per cent.

Classification by Site of the Primary Lesion. In our series the site of origin of the primary growth stood out as the most important single sign. Accordingly, the cases in Group A have been classified into four divisions, depending on whether the lesion started at the tip, lateral border, dorsum, or base of the tongue (Table III).

Nearly half of the cases had their origin in the lateral margins, a fact which coincides with the findings of other authors. Another important result of a classification of cases according to the site of the primary lesion is the clear evidence that the results of five year cures deteriorate progressively from the tip to the borders, the dorsum and the base.

TABLE III

CASES GROUPED ACCORDING TO SITE—WITH CORRESPONDING FIVE YEAR STATISTICS

Group A: 27 Cases

Site	Number of Cases	Per Cent of Total Number of Cases	Number of Five Year Cures	Per Cent of Five Year Cures
Tip	2	7.4%	1	50.0%
Border	13	48.2%	5	30.8%
Dorsum	9	33.3%	1	11.1%
Base	3	11.1%	0	0.0%

TABLE II

CASES GROUPED ACCORDING TO STAGES—WITH CORRESPONDING FIVE YEAR STATISTICS

Groups A and B (81 Cases)

Stages	Number of Cases	Per Cent of Total Number of Cases	Number of Five Year Cures	Per Cent of Five Year Cures
Stage I: Primary growth less than 1.5 cm. diameter	9	11.1%	5	55.5%
Stage II: Primary growth less than 3 cm. diameter	14	17.3%	7	50.0%
Stage III: Primary growth of indeterminate size with unilateral operable cervical nodes	30	37.0%	7	23.3%
Stage IV: Primary growth with invasion of surrounding structures and inoperable cervical metastases	28	34.6%	1	3.6%

But the location of the lesion is not necessarily decisive in the determination of prognosis and success of treatment. Other etiological factors, as for instance the duration of symptoms prior to medical examination, may be assumed to be at least of secondary importance.

It has been our experience that the localized type of neoplasm is most commonly encountered at the tip, and occurs with increasing rarity the closer the lesion is situated to the base. The reverse is true with regard to the invasive type of primary lesion. As the infiltration of adjacent structures (floor of the mouth, subglottic tissues, tonsillar pillars) is linked to the invasive type of growth, such infiltration occurs most frequently in primary lesions, originating from the base of the tongue. Furthermore, secondary (metastatic) involvement of cervical nodes develops more often from primary lesions at the dorsum or the base of the tongue than from growths at the tip or at the lateral margins. Finally, even the degree of histologic malignancy appears to increase from the tip towards the base. At the tip, the adult, keratinizing type of squamous cell epithelioma appears to be the rule, while the embryonal nonkeratinizing, anaplastic type of high grade malignancy is most common at the base of the tongue.

Frequency of Metastatic Involvement of Cervical Lymph Nodes. The presence or absence of a metastatic involvement of cervical lymph nodes is in every respect one of the most important factors in diagnosis, therapy and prognosis. Without wishing to consider the two controversial problems of the manner in which infection proceeds from the primary lesion to the region of secondary involvement, and whether palpation of a node indicates evidence of such malignant involvement,[14] it appears to be of interest to tabulate the cases in which at time of examination, or in the later course of the disease, cervical lymph nodes were found to be affected, as judged by the methods of clinical observation. Martin *et al.*[6] reported an incidence of 38 per cent at admission, while in 24 per cent cervical nodes became subsequently involved. Whitcomb[17] found metastatic involvement in eight "anatomic triangles" of the neck; the submaxillary region was involved in about two-thirds of all cases of cervical metastases, while in about one-fourth of all cases the carotid triangle was the secondary site.

TABLE IV

PRESENCE OF METASTATIC CERVICAL LYMPH NODES AT TIME OF EXAMINATION OR DURING THE COURSE OF THE DISEASE—WITH CORRESPONDING FIVE YEAR STATISTICS IN GROUPS A AND B (81 CASES)

	Number of Cases	Per Cent of Total Number of Cases	Number of Five Year Cures	Per Cent of Five Year Cures
Metastatic lymph nodes at time of admission	44	54.3%	7	15.9%
No metastatic lymph nodes at time of admission but developing during course of disease	9	11.1%	1	11.1%
No metastatic lymph nodes at any time	28	34.6%	12	42.9%

The present series confirms the general observation that cancer of the tongue is a highly aggressive disease in which metastases develop early (Table IV).

The five year end-results demonstrate anew that secondary involvement of the cervical lymph nodes has a decided influence on the success of treatment. The comparatively high percentage of five year cures in cases with metastatic evidence at time of examination may be due to the relatively small total number of cases in this

Fig. 7. Keratinizing type of epidermoid carcinoma, Grade I and II.

series or, on the other hand, it may indicate an improvement in therapy.

It should be mentioned here that the different systems of classification, using as a basis respectively the duration of symptoms, the site and size of primary lesio or the metastatic status are not mutually exclusive of each other. Hence definite conclusions should be drawn from any specific classification only in exceptional cases; for instance, carcinoma at the base of the tongue will almost uniformly prove to be a lesion of long standing.

Histopathology. Biopsy was performed in all cases immediately prior to the start of treatment. Microscopic examination of the tissue specimens from primary lesions led to results which are in accord with the findings of Blair *et al.*,[1] and most other authors, namely that the species of malignant growth most frequently encountered is squamous cell epidermoid carcinoma. In our patients, this type of malignancy was found to be present in 90.3 per cent of all instances, a figure which resembles closely the ratio given by Richards[14] (91 per cent).

The division into three grades of malignancy (keratinizing; nonkeratinizing, but still adult cell type; anaplastic) seems preferable to the four grades of Broders' index which result from a purely quantitative approach and, accordingly, our cases of squamous cell epidermoid carcinoma were classified as Grade I in 25.5 per cent, Grade II in 60.8 per cent (Fig. 7), and Grade III in 13.7 per cent (Fig. 8).

Squamous cell epidermoid carcinoma usually starts as a thickening or a local overgrowth. Invasion becomes manifest by a lesion with rolled edges and induration. In the later course, this type of malignant growth leads to an indurated widening of the organ in the portions which have been attacked. When at the same time secondary invasion of adjacent tissues takes place, the movement of the tongue will be severely curtailed.

Dissemination may occur at any time after invasion of the basement membrane of the mucosa. This process is in no way related to the size of the primary lesion; we have seen cases where a Grade I squamous

Fig. 8. Nonkeratinizing type of epidermoid carcinoma, Grade III.

cell epidermoid carcinoma of a few weeks' standing had caused lesions of only moderate size, but at the same time had metastasized into the cervical lymph nodes. Yet, early attack of structures below the clavicle is exceedingly rare. It is assumed that dissemination is brought on by lymph embolism.

Of the less frequent types of malignant growths, keratinizing cystic epidermoid carcinoma occurred once in the present series, while papillary epidermoid carcinoma was encountered in 2 patients.

Transitional cell carcinoma was found in only 2 cases, and its ratio of frequency relative to squamous cell epidermoid carcinoma of all grades amounted to about 3 per cent. The transitional cell type is restricted to the base of the tongue and the region of the vallate papillae, and can be recognized by the bulky appearance of the local overgrowth (Fig. 9). This type is highly malignant, spreads rapidly and leads very early in its course to invasion of surrounding tissues and cervical metastases.

Lymphoepithelioma appeared in 2 cases of the present series. Growths of that type start nearly always along the posterior third of the lateral margins, or at the base of the tongue; the primary lesion is generally so small that repeated examinations are required in order to establish the correct diagnosis. The secondary involvement, on the other hand, is as a rule quite bulky. Furthermore, one case of a primary lymphosarcoma of reticular cell type was encountered.

Diagnosis. Cancer of the tongue is a highly aggressive disease. "The continual movement of the tongue in speaking, swallowing, chewing, etc., together with the rich distribution of lymphatics, makes the likelihood of extension of the disease very great, and such distribution takes place early."[8] Therefore, not even a day is to be lost before starting treatment of the primary growth. In a certain sense, the usual relation between diagnosis and treatment is reversed because of this character of lingual carcinoma: treatment is instituted on the basis of a first clinical impression, while the exact diagnosis can be expected only on the basis of biopsy and pathological examination—a procedure which in many cases is repeated before a final decision can be made. In any case it will take days before the character and extent of the malignant involvement is entirely understood; but cancer of the tongue does not permit such a delay and therefore treatment cannot wait until the clinical diagnosis has been completed through pathological and serological examinations.

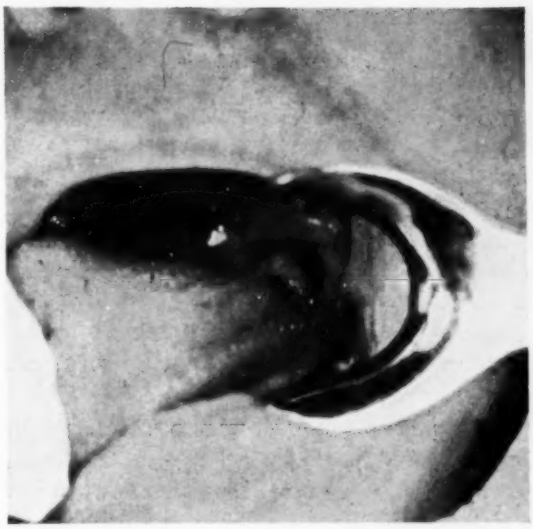

Fig. 9. Anaplastic type of epidermoid carcinoma in the usual site near the lingual tonsil.

Clinical diagnosis begins with a complete examination. From the duration of symptoms, age and sex of the patient, size and site of the lesion, appearance of the original growth, and the presence or absence of distant involvement, a tentative diagnosis can be derived. Under certain circumstances even such a conditional conclusion may be complicated by difficulties: for example, if the only pathological evidence consists in a cervical involvement it is sometimes difficult to detect the primary lesion in the lingual mucosa.[17] On the other hand, the lingual growth itself may be but a metastasis of a primary lesion in another organ of the body. A careful search for other diseases is required, therefore, before

the final judgment on the clinical basis can be made.

However, in all instances the clinical impression must be verified by a pathological report. Biopsy should be performed during the first examination, regardless of how obviously benign the ulcer or nodular growth may appear to be. Even in cases where the patient produces evidence of a positive Wassermann or Kahn test, or when it seems advisable to take smears in order to rule out the presence of Vincent's angina, immediate biopsy is required. A tissue specimen of a diameter of between 3.0 mm. and 5.0 mm. is necessary in order to obtain sections of adequate size. If the growth is not ulcerated, the specimen is removed with a scalpel. For ulcerating lesions a sharp biting forceps, which will not crush the specimen, is used. In order to obtain a fragment from a primary growth at the base of the tongue, a curved specimen forceps guided by a throat mirror is employed. In all cases, the tissue portion should be taken from the edge of the ulcer, and it is advisable to secure two specimens from the peripheral zone. Blair *et al.*[1] caution that a biopsy specimen removed from the protective inflammatory wall which often surrounds the lesion may not include part of the true growth and therefore fail to indicate existing malignancy. The section is immediately hardened by immersion into a fixing agent (usually Zenker's solution); after a period of from twelve to twenty-four hours it is prepared in paraffin and stained for microscopic study.

In our experience, the removal of a tissue fragment for biopsy has not increased the incidence of metastases. While not one hour's time should be lost in performing biopsy, the immediate institution of treatment makes it unnecessary to insist on a pathological report within twenty-four hours.

Differential Diagnosis. Cancer of the tongue has to be distinguished from several other diseases producing similar clinical symptoms on the lingual mucosa. Differential diagnosis has to take into consideration ulcers of tuberculous or luetic origin, ulceration on the basis of advanced leukoplakia, papilloma, fibroma, granulomatous neoplasm (caused by Vincent's angina, or of traumatic origin), etc. Of all these diseases luetic lesions occur most frequently. The presence of any of the other pathologic conditions almost invariably rules out lingual carcinoma, even though they may sometimes indicate a precancerous state. A diagnosis of syphilis, on the other hand, is not to be misunderstood as disproving synchronous cancer in the affected area. On the contrary, "the presence of a positive Wassermann reaction strongly suggests that an associated chronic ulcer of the tongue is cancer rather than any other condition."[6]

Syphilis concomitant with cancer of the tongue was found to be present in about 13 per cent of all cases. Richards[14] reports an incidence of less than 11 per cent, while others noted the presence of syphilis in up to one-third of their cancer patients. Therefore, serodiagnosis is unable to exclude the possibility of cancer, and biopsy should be performed without delay. It is doubtful whether darkfield illumination microscopy for the detection of spirochetes is indicated whenever lingual carcinoma is suspected.

Treatment of the Primary Lesion. Treatment of the primary lesion, including roentgen therapy as well as local and general hygienic care, is begun at the time of the first consultation. Oral hygiene is necessary to check the septic condition of the mouth generally encountered in cases of lingual carcinoma. Whenever the infection is combined with pyorrhea, or when the growth itself is inflamed, frequent saline mouth washes are recommended. If indicated, penicillin is used in an aqueous solution containing 200 Oxford units per cc.; 2.0 cc., or about one-half of an eye-dropper full sprayed into the mouth four times daily, is prescribed. Penicillin lozenges are even more satisfactory, but cannot be used freely in a dispensary. Penicillin has proved very effective in the control of oral sepsis, and seems to be preferable to medication with

sulfa drugs. Infection which formerly was one of the principal factors leading to dissemination of epidermoid carcinoma has now been largely eliminated through topic and systemic use of the sulfa drugs and penicillin.

In many cases, dental prophylaxis is required, and sharp and jagged teeth must be filed smooth. In order to freshen up the mucous membrane and as an aid to the healing process after radiation treatment, vitamin therapy, with doses several times the normal daily requirements, is instituted. While the value of vitamins B_1 and B_2 for this purpose has been clearly pointed out,[7] vitamin C proved in our experience also to be of importance.[9]

Fractional Peroral Roentgen Irradiation. In the treatment of the primary lesion, surgery has been replaced by irradiation. Whenever possible intracavity treatment cones are used perorally, while external fields of irradiation are employed only as a supplement, or when the site of the lesion cannot be reached by a peroral cone. Irradiation is applied directly to the primary lesion; as a short target-to-skin distance is used, the tissue exposure is limited in area as well as volume, thus permitting the administration of a larger dose at each session. Due to the efficiency of this method of irradiation, the series of treatments can be shortened to a period of ten to fourteen days, and the disease can be controlled with a lower total dose than was previously considered possible. By this technique, the danger of radionecrosis has been minimized and in combination with subsequent interstitial radium needle therapy this method has proved to be highly satisfactory.

While, of course, the exact choice of dosage and approach must remain an individual problem to be decided anew for each patient, it is possible to outline the general principles of this technique. As has already been stated, roentgen therapy is started at the time of the patient's first visit. The oral cavity is used as the exclusive portal of entry for all lesions except for those situated at the base of the tongue. The diameter of the oral cone employed varies between 2.5 cm. and 4.2 cm.; it depends upon the size of the growth and its location, but may have to be reduced because of a restricted dental aperture. For lesions on the tip of the tongue the diameter of the cylinder is 1.0 cm. greater than the diameter of the growth. For lesions along the lateral borders the size of the cone is not determined by the length of the growth but by its depth, and the diameter of the cone should be 1.0 cm. greater than this measurement of invasion. On the average, cylinders with a diameter of between 3.0 cm. and 3.75 cm. have been used for the treatment of these lesions. If the cooperation of the patient can be obtained, he may hold the tip of his tongue during irradiation, to keep the organ in a fixed position and, if possible, outside the dental aperture. When the lesion is situated along one of the margins, the patient may draw the invaded portion of the tongue closer to the incisors and away from the alveolar ridge, the point of greatest danger of a possible development of subsequent osteoradionecrosis.[16]

Lesions at the base of the tongue will not receive sufficient irradiation through the dorsal portal alone, but require additional portals for supplementary external radiation, either through the floor of the mouth on each side, or two lateral neck portals. The total amount to be administered from these convergent approaches has to be carefully calculated on the basis of the tolerance dose established for the mucosa of the posterior wall of the pharynx.

Whether the radiation is administered exclusively through the oral cavity, or whether supplementary external fields are used, a daily dose of 400 roentgens, measured in air, is considered desirable. This roentgen irradiation is performed with shockproof equipment operating at 200 kilovolts and 15 milliamperes, with a Thoraeus filter equivalent to 2.0 mm. of copper. The half-value layer of this radiation is 1.9 mm. of copper. Special intra-oral cones, some cylindrical, some conical, depending upon the diameter, permit a

target-skin distance of only 25 cm. For external irradiation a target-to-skin distance of 50 cm. is used, on fields of 100 sq. cm.

The total as well as the daily dose depends upon the diameter of the cone: when a 2.0 cm. diameter cone is employed, the total dose amounts usually to 4,800 roentgens, measured in air, to be administered on twelve consecutive days; with a 4.0 cm. diameter cone, the total dose is reduced to 4,000 roentgens, measured in air, to be administered on ten consecutive days.

It should be noted that the total dose required in the described procedure (4,000 to 4,800 roentgens in air) is lower than that employed in other systems. Cade's[2] method requires 6,000 to 8,000 roentgens, and similar doses are reported by Richards.[14]

Interstitial Radium Needle Therapy. The duration of treatment has been reduced by the prompt use of interstitial irradiation. Radium needles are implanted on the last day of roentgen therapy. The dose of interstitial radiation required, and the use of either single or double needles depend upon the site as well as the size of the primary lesion and on the total dose of roentgen radiation which has been administered. Single cells measuring 11.5 by 1.0 mm. have platinum needle sheaths to give a 0.5 mm. platinum filter; they contain 2.0 mg. radium salt. Double needles measuring 23.0 by 1.0 mm. contain 4.0 mg. radium salt; 0.5 mm. platinum filter is used.

The needles are inserted into the peripheral zone of the growth and directed radially or conically toward the base of the growth according to the depth of invasion, with concentration at the margin. The imaginary surface formed by these needles might be said to vary between a plane and a shallow cone, with the apex at the base of the lesion. They are placed 1.0 to 2.0 cm. apart and as close to each other as possible on several planes. The procedure is carried through with all possible precaution to avoid infection, and is performed under local or block anesthesia with 2 per cent novocaine.

The dose for interstitial radiation in the anterior two-thirds of the tongue varies between 800 and 1,600 mg-hr., the average dose being 1,200 mg-hr. In this portion of the tongue, six to ten single 2.0 mg. radium needles are employed. The base of the tongue is accessible for implantation of interstitial needles through the dorsum, through the posterior floor of the mouth, or externally through the subglottic tissue. In some cases it may be necessary to combine two or all of these approaches. For lesions at the base of the tongue, only double needles with a radium content of 4 mg. are used. Depending upon the diameter of the growth, five or six of the larger needles are inserted into the base of the tongue, immediately under the surface, behind the circumvallate papillae. One or two may be implanted into the growth through the posterior part of the floor of the mouth. The dose for interstitial radiation at the base of the tongue varies between 600 and 1,000 mg-hr., the average dose being 800 mg-hr.

In gamma roentgens, the average exposure of 1,200 mg-hr. would amount to 4,800 gamma roentgens for a lesion of 2.5 cm. diameter and a volume of about 8 cc.; this would be equivalent to approximately 4.8 erythema doses. If it is assumed that the tissue exposure at the base of the lesion corresponds to 75 per cent of the roentgen exposure in air, it would average about 3,600 "tissue roentgens" or roughly 5.2 erythema doses (Pugh).[10]

Adding these two *biological* values of exposure, the total is found to be 10 erythema doses, an amount which in this approximation agrees well with the standards for the combination of gamma roentgens (r_γ) approved by the Standardization Committee of the American Radium Society.

In the average case, the needles remain in place for about three days. Whenever swallowing proves to be difficult, a feeding tube is inserted; in all other instances it is sufficient to prescribe a liquid diet. During daytime, a cleansing mouth wash is frequently applied and, according to the degree of inflammation, penicillin, topically or systemically.

During interstitial therapy, an incipient mucositis due to roentgen irradiation is encountered, which will persist for five or six weeks. The needle holes seal over, and the tumor area soon develops a smooth, raw surface. With a subsiding reaction the mucosa regenerates from the periphery towards the center, and the area of epithelitis diminishes. Radiation necrosis in soft tissues, as it occurred from the use of radon seeds in our early cases, was not observed subsequent to implantation of radium needles.

The fact that the mandible receives apparently only minimal radiation is partly due to the careful direction of the peroral roentgen therapy, and partly to the use of radium needle implantation. At no time were more than 20 per cent of the needles within 1.5 cm. of the periosteum of the mandible, and the remaining 80 per cent were within 2.0 to 4.0 cm. This distance seems adequate for the protection of maxilla and mandible against osteoradionecrosis.

The avoidance of many complications in the post-irradiation period can thus be traced to the use of radium needles in the place of radon seeds. The conclusion that radium needles are preferable resulted from our early experience with certain advanced cases in which radium needles were used once, or even twice, with good palliative effect. Radiation necrosis did not occur as frequently as after implantation of radon seeds, and the result was much less painful. It has not been necessary to remove the growth following the use of interstitial needles as it had been unavoidable in the case of radon seeds. Thus it would seem that radon seeds have only a place in interstitial irradiation where the limited size of the primary growth renders the use of radium needles impracticable. In the present series, therefore, implantation of radon seeds has been restricted to cases where the diameter of the lesion was 1.0 cm. or less.

When cancer of the tongue is superimposed upon leukoplakia, cumulative irradiation by the peroral and interstitial methods frequently produces excellent results on the affected growth. However, neither the cause of leukoplakia nor the tendency towards malignant changes has been remedied so that, not infrequently, subsequent primary lesions develop on other surfaces of the tongue, or elsewhere in the oral mucosa.

Primary growths treated by the outlined method have healed in 41.7 per cent of the entire series, and in 52.4 per cent when only Group A (the cases from private practice) is taken into consideration.

Palliative Therapy of the Primary Growth. The combination of peroral roentgen therapy with interstitial irradiation by means of radium needles permits certain modifications which render this procedure very useful for the palliative treatment of the primary growth. In all cases in which, because of the advanced state of the disease, a cure cannot be expected, every possible means must be employed to relieve, or at least to alleviate the suffering of the patient.

Palliative treatment also begins with roentgen therapy. The radiation is chiefly directed towards neighboring structures which have been secondarily involved by the malignant growth originating in the lingual mucosa, for example the anterior tonsillar pillars, the floor of the mouth and, particularly, the periosteum and osseous structure of the alveolar ridge. By peroral administration, a total dose of 4,000 roentgens, in air, usually proves sufficient to relieve radiating as well as local pain. An external portal is used exclusively in those cases where it is possible to aim the radiation through cervical nodes into the primary growth. Regardless of the approach, such roentgen therapy may be accomplished within a period of ten to fourteen days.

Immediately after, interstitial irradiation by means of radium needles is instituted. Through normal mucous membrane, the needles are inserted equidistantly throughout the growth, with special attention to invaded surrounding structures. In order to

effect the most uniform irradiation, the single needles should be distributed as evenly as possible throughout the area of the lesion. A cancerous growth involving one-half of the tongue will require 1,500 to 1,600 mg-hr. while in more extensive lesions 2,000 mg-hr. may be needed. These doses will permit a possible repetition of interstitial irradiation.

Roentgen therapy may also be repeated after an interval of three months. But before a second course of treatments is initiated, the advisability of further palliative therapy of the primary growth should be carefully weighed on the basis of the evidence of metastases as well as the general condition of the patient. In cases of this type, an excessive amount of radiation might easily prove to be more injurious and more painful than too little treatment. The decision on the proper type and amount of radiation must of necessity depend upon the skill of the radiologist as well as on the probable life expectancy of the individual patient.

Treatment of Metastatic Cervical Nodes. The treatment of metastatic disease in the cervical lymph nodes presents special difficulties. There can hardly be any doubt that successful therapy of this common secondary involvement is as important for the control of lingual carcinoma as the cure of the primary lesion. Metastatic involvement of the neck takes place so often and so early in cancer of the tongue, that its therapy must be considered an intergral part of the treatment of the primary disease. However, since diagnoses as well as therapy presents a most difficult problem, it is by no means surprising that little agreement exists concerning the most advisable procedure. The differences between individual cases of cervical involvement are so great that there is no single approach which can be applied to all possible variations.

In the present series, the primary plan of treatment combined preoperative roentgen therapy with radical neck dissection. The cervical lymph nodes act as a filter or a protective screen inhibiting—or at least retarding—dissemination of embolic cancer cells.[4] Roentgen irradiation increases this defensive function of the lymph nodes, which assumes its greatest importance during the period in which radiation is being administered to the primary growth. Roentgen rays have a direct effect on the metastatic cancer cells in the neck. Therefore, it is advisable to begin heavy roentgen irradiation of the cervical nodes simultaneously with the therapy of the primary lesion.

This preoperative roentgen therapy is indicated only when palpation reveals one or more nodes to be affected. But the decision depends entirely on the clinical impression, taking into consideration the position and mobility of the nodes as well as the possible presence of a more distant metastatic involvement. Differentiation by palpation of malignant involvement from a hyperplastic inflammatory node is not possible in all cases,[3] but histopathological diagnosis after aspiration biopsy is equally unreliable.[17]

Roentgen therapy in this preoperative phase calls for a total dose of 4,000 roentgens in air, to be administered within a period of no more than fourteen days. By following this program, the first stage in the treatment of the metastatic cervical nodes will be terminated at about the same time as the complete course of therapy to the primary lesion. On the average, the daily dose amounts to 400 roentgens. The identical shockproof equipment is employed as in roentgen irradiation of the lingual growth, and all the factors are the same as described above. The nodes are treated separately and the width of the cone is usually 1.0 cm. larger than the estimated diameter of the node.

By the described course of irradiation, cervical disease will be at least temporarily arrested. This fact is of considerable importance as the next step—radical neck dissection—should in no case be undertaken earlier than two or three weeks after the

treatment of the primary lesion has been terminated. If by that time it is evident that the lingual growth has been responding satisfactorily to radiation therapy, neck surgery can be undertaken, provided all of the following conditions are fulfilled: (1) the general condition of the patient must be good enough to permit such a major surgical procedure without incurring undue risk; (2) the life expectancy in the individual patient has to be weighed carefully against the statistical surgical risk entailed in any radical operation; (3) cervical nodes are considered as operable only if the primary lesion has not transcended the midline and has, on the basis of a primary growth biopsy, proved to be of only limited malignancy (squamous cell epidermoid cancer, Grade I or II); (4) surgery is indicated only if the secondary metastatic involvement has remained unilateral (Fig. 10); (5) furthermore, the node—or nodes—must be movable, and show little evidence of invasion. An irregular outline of a metastatic gland, or its partial fixation, indicates that the involvement has extended beyond the capsule, and in such cases dissection would lead to contamination of the operative field, and to subsequent recurrence.[3]

Radical block dissection of the neck is performed under local anesthesia. The operative area extends horizontally from the midline of the neck to the anterior border of the trapezius muscle, and in the vertical direction from the inferior edge of the mandible and the mastoid process to the clavicle. "All lymph node-bearing tissue between the platysma myoides muscle and the deep muscles is removed, including the jugular vein, the sternomastoid and omohyoid and the submaxillary salivary gland."[6]

In cases of metastatic involvement of the cervical lymph glands where radical block dissection is not feasible, an alternative plan has been developed in which interstitial irradiation supplements more extensive roentgen therapy. In this conservative method a total dose of 5,000 roentgens,

Fig. 10. Advanced carcinoma invading half of the tongue, with unilateral metastatic nodes.

measured in air, is administered within a period of two weeks. The size of the cylinder is slightly larger than the diameter of the nodes; all other factors of irradiation are the same as in preoperative roentgen therapy.

Immediately after this course of treatment is terminated, radium needles are implanted around the nodes. The radium needles are of the same kind as those employed for the primary growth. The total dose of interstitial radiation to be administered to the nodes is calculated on the basis of the grade of malignancy of the primary growth as well as on the extent of metastatic involvement, and varies between 2,000 and 4,000 mg-hr. Interstitial irradiation will require from four to six days depending upon the size and number of the needles which are inserted.

Results of Therapy. Statistical evaluation of the therapeutic results obtained by a

specific method for the treatment of cancer of the tongue encounters great difficulties. The scientific value of any classification of cases according to operability or curability must remain doubtful, as the element of subjective choice can never be entirely excluded.[5] An objective evaluation, therefore, should be based on the actual survival of patients, free from recurrences, after a specified number of years. Richards[13] published comparative figures for patients surviving after three and five years respectively. In one study, the author proposes to count a case as "controlled" if no recurrence took place during the patient's lifetime, provided he lived at least two years after termination of treatment. All other cases are regarded as "uncontrolled."

As the present series includes cases which had been treated as long as fourteen years ago, it is obvious that after such a long time many other diseases as well as new primary growths and recurrences were bound to occur. Therefore, it seemed to be necessary to consider the material on the basis of results as they appear strictly at the end of five years subsequent to termination of treatment.

TABLE V

FIVE YEAR END-RESULTS IN CASES OF CANCER OF THE TONGUE PRESENTED ACCORDING TO THE METHOD OF MARTIN ET AL. THE EXACT PERIOD OF SIXTY MONTHS FOLLOWING TERMINATION OF TREATMENT IS CONSIDERED. PATIENTS WHO HAD BEEN PREVIOUSLY TREATED ELSEWHERE AND WERE MORIBUND AT ADMISSION HAVE BEEN DEDUCTED

	Group A: Cases from Private Practice	Group B: Cases from the Tumor Clinic Veterans Administration	Entire Series: Groups A and B
Total number of patients	27	54	81
Indeterminate group: Death as a result of other causes and without recurrence	1	1	2
Lost track of without recurrence	3	2	5
Moribund at admission after previous treatment elsewhere	1	9	10
Total number of indeterminate results	5	12	17
Determinate group: Total number minus those of indeterminate group	22	42	64
Failures: Dead after recurrence but not as a result of cancer	—	2	2
Dead as a result of cancer	15	25	40
Living with recurrence	—	2	2
Total number of failures of treatment	15	29	44
Successful results: Free from disease strictly five years after termination of treatment	7	13	20
Successful results as per cent of determinate group	31.8%	30.9%	31.3%

But still another correction appeared to be necessary. There was, especially among the older cases, a considerable number of patients who were admitted only after having passed through primary therapy elsewhere. Consequently, failures in those cases cannot be attributed to the procedure which has been presented here. Therefore, in order to arrive at a more adequate evaluation, all cases which had received primary treatment before admission, and were furthermore in a moribund condition when first seen, have been deducted from the total number of patients. While in Group A there occurred only 1 case of this kind, there were 9 such cases in Group B. These patients died within an average of five weeks—one dying two days, another five days after admision.

On this basis, therapy in Group A was successful in 31.8 per cent, in Group B in 30.9 per cent, and in the entire series in 31.3 per cent of cases (Table v).

SUMMARY

1. A flexible plan for the eradication of the primary lesion as well as of metastatic cervical involvement in cancer of the tongue is presented which—in the author's experience—has minimized subsequent tissue breakdown and osteoradionecrosis.

2. The incidence of lingual carcinoma can be drastically reduced by early recognition and treatment of precancerous lesions; duration of symptoms at time of first examination is directly related to the rate of successful five year cures.

3. A classification is submitted, grouping cases at the same time according to the size of the primary lesion and possibly secondary involvement—by way of topical invasion or metastases.

4. The relation between site of the primany lesion, etiology, and degree of malignancy is pointed out.

5. Definite diagnosis of the character of a lesion is possible only on the basis of biopsy and pathological examination. In the present series no ill effects from biopsy were observed.

6. The aggressive character of lingual carcinoma necessitates immediate beginning of therapy—even before the pathological diagnosis can have been definitely established.

7. Through medication with penicillin (and the sulfa drugs) infection of the primary lesion and resultant dissemination of cancerous cells have largely been eliminated.

8. The primary lesion is treated exclusively by irradiation, combining roentgen therapy with subsequent implantation of radium needles.

9. Roentgen treatment proceeds perorally; external approaches are used only in lesions at the base of the tongue, in order to supplement irradiation through the dorsal lingual portal.

10. By using a short target-skin distance, the daily dose has been increased, while the total dose has been considerably lowered; thus, the course of roentgen treatments has been reduced to ten or twelve days.

11. For interstitial radium therapy, platinum needles have been almost exclusively employed.

12. Palliative therapy of the primary growth combines peroral roentgen treatment with implantation of radium needles. Smaller doses are employed, permitting repetition of both types of irradiation.

13. In the treatment of metastatic cervical nodes, preoperative roentgen therapy is combined with subsequent radical neck dissection; when surgery is contraindicated, administration of a larger dose of roentgen rays is immediately followed by implantation of radium needles.

14. An unselected, consecutive series of 81 cases is reviewed. The described course of treatments led to five year cures in 31.3 per cent of all cases.*

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* For discussion, see page 203.

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CARCINOMA OF THE ANUS*

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IT IS an accepted fact that the best treatment of adenocarcinoma of the rectum is by surgery. While there are recoveries after irradiation, the number is so small that its use is limited to those individuals refusing surgery, to those whose health makes them unsuitable for the radical operation, or to those who are too far advanced for such a procedure. However, when we consider carcinoma of the anus, there may be a difference of opinion, since the great majority of those tumors are squamous cell epitheliomas, with an occasional basal cell carcinoma. Tumors of this variety are successfully treated by irradiation in other parts of the body, so there is no reason why they should not be responsive in this location. Furthermore, they are readily accessible, since they originate either outside or just inside the anal sphincter.

In 1939 I presented before this Society our experiences with 13 patients whom we had the opportunity of seeing and treating.[1] These patients have been followed and a new group of 12 additional patients have been studied, paying particular attention to the permanency of recovery to see if we are justified in continuing this method of approach.

The technique, as originally described, has been followed and will not be repeated here. The dosage has varied according to the size and location of the lesion. In the original paper, I did not give the tumor dose, but in this I have attempted to estimate it as closely as possible in roentgens.

TABLE I

FIRST SERIES—CARCINOMA OF THE ANUS
PERMANENCY OF RECOVERY

A Living / Case	Age When Last Seen	Time Followed	Operable	Result Sphincter Control
I	84	7 yr.	Yes	Perfect
IV	72	7 yr.	Yes	Tight
V	?	6 yr.	Yes	No record
VI	87	10 yr.	Yes	No complaints
VIII	60	9 yr.	Yes	No. Developed radionecrosis
IX	56	3½ yr.	Yes	Lost. No complaints
XI	67	1 yr.	Yes	Lost track of. No record
XIII	75	8 yr.	No	Tight
B Dead / Case	**Age When Last Seen**	**Time Followed**	**Operable**	**Cause of Death**
II	70	6 mo.	No	Internal metastasis
III	59	6 mo.	No	Internal metastasis
VII	77	6 mo.	No	Internal metastasis
X	51	3 mo.	Yes	Internal metastasis
XII	73	2 yr.	No	Unknown

* Presented at the Twenty-eighth Annual Meeting, American Radium Society, San Francisco, Calif., June 8–9, 1946.

[1] Meland, O. N. Carcinoma of the anus. Am. J. Roentgenol. & Rad. Therapy, 1940, *43*, 706–710.

Table I gives the results to date in the first series presented originally.

In the second series we have 14 patients, but 2 are so recent that they are not included, so only 12 are presented. However, the 2 not discussed were both basal carcinomas inside the sphincter, and in both the lesions disappeared as the result of irradiation alone.

Table II gives an outline of these cases and the therapy.

TABLE II

Case Year	Name	Sex Age	Description	Pathology	Symptoms and Operability	Treatment	Living	Remarks
A 1939	C	F 37	Ulcer, 1 cm. diameter	Sq. cell epith. Grade 1	Bleeding hemorrhoids 1 year Operable	Supervoltage roentgen therapy, 900 r—anus. *T.D. 710 r Radium—contact, 2 mm. gold filter, 400 mg-hr.	Yes 7 yr.	No complaints. Originally had hemorrhoids injected
B 1939	S	F 73	Firm, hard mass in rectovaginal septum, 6 cm. diameter, involving sphincter	Sq. cell epith. Grade 3	Bloody discharge from anus. Feeling of fullness in rectum Inoperable	Supervoltage roentgen therapy, 2 series, 4 ports, 2 anterior, 1 sacral, 1 perineal. 1st series: 2100 r to each port. 2nd series: 1050 r to each port. *T.D. 5939 r Radium—platinum needles 0.5 mm. filter, interstitially around lesion; 1152 mg-hr.	Yes 7 yr.	No complaints. Slight telangiectasis. No sphincter disturbance This patient was inoperable
C 1940	D	F 63	Sloughing, ulcerating lesion, 2 cm. diameter, anal margin and sphincter	Sq. cell epith. Grade 3	Rectal bleeding Operable	Treated elsewhere. Dosage of high voltage x-ray and radon seeds indeterminate	Yes 6 yr.	Radionecrosis healed. Sphincter tight and somewhat impaired
D 1940	A	F 50	Infiltrating mass involving rectovaginal septum, extending into sphincter. Node in groin	Sq. cell epith. Grade 3	Rectal bleeding for 6 months Inoperable	Supervoltage roentgen therapy, 3 ports, anterior, posterior and perineal. 2100 r to each port, 10×10 cm. High voltage roentgen therapy, 50 cm. distance, 0.5 mm. copper, 1 mm. aluminum filter, 3400 r, 10×10 *T.D. 3900 r No radium used	No Died after 4 yr., of carcinoma	1943—had nephrectomy for tuberculosis of kidney. Died 1944 frozen pelvis
E 1941	H	M 39	Indurated lesion inside anal margin. Had cautery excision 8 mo. ago elsewhere. Now recurrent	Sq. cell epith. Grade 3	Bleeding for 6 mo. Had an ischiorectal abscess drained 4 yr. earlier Inoperable	High voltage roentgen therapy elsewhere (dose not determined) Supervoltage roentgen therapy, 2 ports, 1500 r to sacral port, 900 r to perineum *T.D. 1896 r Radium—platinum needles, 792 mg-hr. interstitially around lesion	No Dead 1942	Patient had a colostomy but disease was progressive. Little benefit from irradiation. Wound badly infected. Some relief from electrocoagulation and splitting sphincter. Lived 1 year
F 1941	M	F 58	Ulcerating lesion 2 cm. diameter, inside anal margin	Sq. cell epith. Grade 3	Rectal bleeding. Had hemorrhoids injected 12 yr. earlier Operable	Supervoltage roentgen therapy, 1800 r to each of 3 ports—ant. pelvic, sacral and perineal. *T.D. 3050 r Radium—platinum needles interstitially, 192 mg-hr. Surface radium—contact, 2 mm. gold, 900 mg-hr.	Yes in 1945	Lesion healed but sphincter became tight. Marked telangiectasia. Seen in 1945 when she had almost complete atresia. Advised perineal excision—refused. Patient lost track of after 4 years

TABLE II—(*continued*)

Case Year	Name	Sex Age	Description	Pathology	Symptoms and Operability	Treatment	Living	Remarks
G 1941	O'B	F 60	Ulcerating lesion 2 cm. diameter, inside anal margin	Sq. cell epith. Grade 2	Rectal bleeding Operable	Supervoltage roentgen therapy, 400 r to anal region, 5×5 cm. *T.D. 3160 r	Yes in 1942	Lesion disappeared. Sphincter intact. Lost track of patient after 1 year
H 1942	C	F 51	Ulcerating lesion, 1.5 cm. diameter, adherent to vaginal mucosa	Sq. cell epith. Grade 4	One yr. ago had hemorrhoids injected one week ago noticed a rectal tag. On investigation it was found to be carcinoma. Operable	Supervoltage roentgen therapy, 1500 r to 2 ports—sacral and perineal. *T.D. 2370 r Radium interstitially—1226 mg-hr. Radium contact— 400 mg-hr. vaginal 600 mg-hr. rectal	No Died 1946 of carcinoma	Lesion healed. Recurred after 2 years. Destroyed by electrocoagulation. Patient died generalized metastatic carcinoma 4 years after treatment
I 1942	M	M 51	Ulcerating lesion, involving skin around anal margin, 4 cm. diameter	Sq. cell epith. Grade 2	Bleeding and irritation around anal margin Inoperable	Supervoltage roentgen therapy, 300 r, 5×5 cm. area, perineal port *T.D. 3300 r	No Died 1943	Patient had a duodenal ulcer and active pulmonary tuberculosis. Developed tuberculous rectal fistula. Had a colostomy done. Died pulmonary tuberculosis. No evidence of carcinoma in treated areas. Lived 1 year
J 1942	R	F 58	Indurated lesion 3 cm. diameter, inside anal margin	Sq. cell epith. Grade 3	Rectal bleeding for 2 mo., with increasing constipation. Five yr., previously had fistula in ano repaired Operable	Supervoltage roentgen therapy, 300 r, 5×5 cm. area, perineum *T.D. 3300 r Radium needles, 1368 mg-hr.	No Died 1943	Local lesion healed. No sphincter disturbance. Died extensive metastasis to lumbar nodes after 2 years
K 1943	B	F 33	Mass 3×4 cm. inside anal margin, involving rectovaginal septum	Sq. cell epith. Grade 4	Tenderness in perineum for 2 wk. Inoperable	Supervoltage roentgen therapy to 4 ports—2 ant., 1 sacral, 1 perineal *T.D. 3700 r	No Died in 3 mo.	Rectal lesion almost disappeared and a small residual lesion was to be treated by radon seeds, but metastasis to the liver was found and she went down-hill rapidly
L 1944	G	M 65	Ulcerating lesion 2 cm. diameter anal margin externally	Sq. cell epith. not graded	Bleeding hemorrhoids for 1 yr. Operable	Supervoltage roentgen therapy 2100 r Low voltage roentgen therapy 3000 r 1 cm. cone *T.D. 5300 r	No Died 1946	Developed metastasis to groin. Nodes removed surgically. Later developed radionecrosis locally. Anal area removed surgically. Died cerebral metastasis after 2 years

* T.D.=Tumor dose in roentgens.

A summary of the second series is given in Table III.

DISCUSSION

In reviewing the question of sphincter control, much of the difficulty may be due to the use of interstitial irradiation, either from seeds or needles. Associated infection may produce more fibrosis with loss of elasticity, resulting in a contracted anus or a spastic one. For this reason external irradiation, when successful in destroying the disease, usually results in less sphincter disability.

Another interesting feature of the study is that of metastasis in the unsuccessful

Table III

SECOND SERIES—CARCINOMA OF THE ANUS
PERMANENCY OF RECOVERY

A Living Case	Age When Last Seen	Time Followed	Operable	Result Sphincter Control
A	44	7 yr.	Yes	Sphincter somewhat tight
B	80	7 yr.	No	Atresia following radionecrosis
C	69	6 yr.	Yes	No complaints
F	62	4 yr.	Yes	Lost—no record
G	61	1 yr.	Yes	Lost. Sphincter perfect
B Dead Case	**Age When Last Seen**	**Time Followed**	**Operable**	**Cause of Death**
D	54	4 yr.	No	Pelvic metastasis
E	41	1 yr.	No	Lost track of
H	55	4 yr.	Yes	Recurred. Operated upon; developed internal metastasis
I	53	2 yr.	No	Internal metastasis
J	60	2 yr.	Yes	Internal metastasis
K	33	3 mo.	No	Liver metastasis
L	67	2 yr.	Yes	Recurred. Died cerebral metastasis

cases. Only a minority developed groin metastasis; the majority had retroperitoneal nodes, liver involvement and even cerebral extension. They, then, behave the same way as uncontrolled adenocarcinomas.

Dosage is always a problem. While 5,000 r is looked upon as necessary for complete destruction, some patients needed less. Others when given 5,000 r developed radionecrosis. This is a rather distressing complication, not only because of the associated pain but also because of the prolonged healing. When this takes place, it is necessary to resort to some surgical procedure for relief. This may be followed by complete or partial loss of sphincter control.

A summary of the whole series is given in Table IV.

Table IV

SUMMARY BOTH SERIES

	Operable	Inoperable	Time Followed
Living—no disease			
9	7	2	6 to 10 yr.
Dead	5	7	3 mo. to 4 yr.
12			
Lost—Free from disease			
4 3	3	1	1 to 4 yr.

CONCLUSIONS

1. Irradiation gives a reasonable hope for complete recovery in carcinoma of the anus, with added hope of sphincter control. This period of recovery with no recurrence lasts well beyond the usual five year period.

2. The treatment carries no immediate mortality.

3. Radionecrosis due to an associated infection of the irradiated field occasionally is seen and may require surgical intervention.

4. Some patients have some atresia of the anus but not enough to seriously inconvenience them. Even with this disability they are better off than the patient with a colostomy.

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DISCUSSION OF PAPERS BY DRS. HUNT, SHARP AND SPICKERMAN, AND MELAND

Dr. Wilbur Bailey, Los Angeles, Calif. Will Dr. Hunt please tell us what he would consider the ideal therapy? He has mentioned several methods of procedure that he has used during the years. What does he use to protect the eyeballs when he gives treatments in this area?

I would like to ask Dr. Sharp why in intraoral therapy he uses the Chaoul type of filter for treatment of cancer of the tongue? One might think that less penetrating roentgen radiation would be more desirable, and that such heavy filtration would have no advantage, but on the contrary might be injurious to structures on the other side such as the mandible.

Dr. E. H. Skinner, Kansas City, Mo. I was surprised at the number of cataracts Dr. Hunt reported, and in the age of his patients. There was a predominant percentage who were over sixty years of age, and so I wonder whether the incidence of cataract, which is large, is attributable entirely to irradiation in these patients. It has not been my experience that we have seen so many cataracts in years after these patients have been cured of a lesion at the eyelids. All of my cases have been treated with radium.

Dr. L. C. Kinney, San Diego, Calif. I have been particularly interested in Dr. Meland's paper as I have seen several of his cases over the past few years.

The fact that recurrences in the aortic nodes are more frequent than in the inguinal nodes makes it impossible to determine the presence of metastasis accurately by palpation of the inguinal nodes. Most of these cases are in the later age groups, and while they may be technically operable, many of them are not clinically operable. The radiation approach to these carcinomas in the lower rectum and the sphincter will take care of a great many of these cases that are not clinically operable, although they may be technically operable.

Dr. Meland's results of 42 per cent five year cures is certainly impressive. One particular case that we have followed of Dr. Meland's was a woman with a carcinoma at the upper end of the anal sphincter which had infiltrated the soft tissues with a mass of about 3 to 5 cm. extending outward from the rectal mucosa. She not only was technically inoperable, but clinically inoperable. We have followed her for seven years and she has no evidence of recurrence following the irradiation.

Dr. Meland raises the question in his paper, is it wise for us to continue along this line? I think that it is important in these cases that are technically or clinically inoperable.

Dr. Charles L. Martin, Dallas, Texas. Dr. Hunt's method of treating carcinoma of the eyelids has been used in our clinic for many years. I would like to call your attention to a troublesome complication of cancer of the inner canthus, which often appears after the primary lesion has healed. It consists of a deep-seated mass, which can be felt through the eyelids, under the edges of the orbit. It is our custom to treat such lesions with low intensity radium needles. If such therapy has produced cataracts, they have escaped our notice. Many of these patients are quite old, and eventually develop cataracts when they are not treated.

Dr. Harry H. Bowing, Rochester, Minn. I would like to compliment Dr. Meland on the results he has obtained from the treatment of anal cancer with irradiation. His results are indeed good, because the disease carries a poor prognosis.

I would like also to re-emphasize the importance of surface rather than intramural application of radium as the initial procedure. After a satisfactory interval of three or four months, the residual indurated regions may be treated by plunging in platinum needles.

The regions of the inguinal lymph nodes are treated with radium surface packs at a distance of 2.5 cm.

When the spread of the carcinoma to aortic lymph nodes has occurred, palliation is all that can be expected.

The loss of sphincteric control and slow healing ulceration are distressing complications of radium treatment of anal carcinoma, and I am rather certain that surface application of radium is the best method to keep their occurrence at a minimum.

In some cases local or regional anesthesia may be necessary for the fitting of the surface applicator and the treatment.

The colostomy is a procedure primarily intended to overcome the obstruction. My colleagues and I do not employ it as a therapeutic procedure for patients treated with radium.

Dr. Hunt (closing). I wish to thank Dr. Bailey, Dr. Martin and the others for their in-

terest and particularly for their enlightening discussions.

In answer to Dr. Bailey's question, we would doubtless agree that the ideal treatment is not a simple formula, but rather individualization according to the extent and depth of the lesion. In general, three to six roentgen treatments delivering a total dosage of around 4,500 to 6,000 roentgens in air is adequate for the average lesion. The penetration can be controlled by combinations of 70 kv. (peak) with no filter in superficial lesions up to 140 or even 200 kv. (peak) filtered through 0.25 to 0.5 mm. of copper to infiltrating lesions. Infiltrating fixed lesions at the inner canthus require deeply penetrating roentgen radiation or a pallisade of interstitial needles as employed by Dr. Charles Martin.

In regard to the incidence of cataract following radium therapy, I must emphasize that this complication has been noted only in association with rather extensive lesions requiring high total dosage. The lowest dosage productive of cataract was 960 mg-hr., of which 360 mg-hr. was applied interstitially and 600 mg-hr. on the surface at the inner canthus. The cataract did not appear until five years after irradiation.

Senile cataracts are frequently seen in elderly patients with cancer of the eyelid unrelated to any therapy. However, cataracts seem to occur at a somewhat earlier age in those eyes which have been heavily irradiated. For example, one of our patients developed an irradiation cataract in the exposed eye within six months, and after eight years he showed senile cataract in the other eye as well. It is well to bear in mind that radiation cataracts can be eliminated by operation and that useful vision can be restored by suitable glasses.

Eyelashes will be lost permanently in areas exposed to carcinocidal dosage of radiation. The loss of lashes is slightly less extensive following roentgen irradiation than after radium, since the treated area can be more sharply circumscribed. Eyelashes may be lost also due to direct destruction of hair follicles by invading cancer.

The local anesthetic agent employed prior to insertion of an eyeshield is one drop of 0.5 per cent pontocaine. It has been necessary to give general anesthesia to one baby treated for hemangioma, in order to permit extraction of a Wölfflin shield from beneath the squinted lids of the uncompromising infant.

Dr. Meland (closing). The aim of all treatment in medicine, of course, is to destroy or control a disease with a preservation of function, no matter whether it is the anus or any other portion of the body. Despite the fact that many of these cases are operable and could be controlled by an extensive surgical procedure, you do not attain that preservation of function which patients desire. They know about colostomies and wish to avoid them.

You are probably wondering why we use roentgen irradiation and then follow with radium. It is very difficult to evaluate the extent of a lesion in the rectum, so we take a broad field of radiation by means of roentgen rays first and then treat the residual by radium. Sometimes we use radon seeds; at other times radium needles interstitially; occasionally it is used as a surface application.

Vol. 57, No. 2

PULMONARY COMPLICATIONS OF DORSAL SYMPATHECTOMY

By LIEUTENANT COLONEL ROBERT C. PENDERGRASS
and
CAPTAIN FRANK F. ALLBRITTEN, JR.
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IN A period of seventeen months, 66 dorsal sympathectomies were done on the Neurosurgical Service of Ashford General Hospital. Of these, 16 were done for major causalgia and 50 were done for vascular disease of the upper extremities. These procedures have not been without postoperative complications. The decision to undertake an elective operative procedure will be determined by balancing the benefits expected against the possibility of injury or death from the operation. The complications to be reported have had no permanent adverse effects as far as can be determined but their potentialities seem worthy of consideration.

ANATOMY AND SURGERY

All operations have been preganglionic sympathectomies with excision of the proximal segments of the second and third intercostal nerves and division of the dorsal sympathetic chain distal to the third dorsal ganglion. The technique used has been that as described by Smithwick[1] with few modifications. The skin incision is centered over the third rib. The underlying trapezius and rhomboid muscles are split in the line of their fibers or are divided transversely. At times a combination of these methods is used. After the ribs are exposed, there may be considerable difficulty in identifying the third rib. The second rib is the more prominent rib and can easily be mistaken for the first, as the first rib is invariably at a higher level than expected. After identification, the proximal portion of the third rib and transverse process of the third dorsal vertebra are resected. A plane of cleavage in the endothoracic fascia is then developed and the pleura is separated from the thoracic wall. Although this may be accomplished without rupture of the pleura, the pleura is often torn. If this accident occurs, the lung can be kept expanded by positive pressure during the remainder of the operation.

The pleura is dissected from the thoracic wall for a sufficient extent to expose the bodies of the second, third, and fourth thoracic vertebrae. It is evident that, as the pleura is dissected from the surface of the vertebrae, the dissection may enter the posterior mediastinum (Fig. 7). The second and third intercostal nerves are isolated and traced proximally; the dorsal, white and gray rami are identified and traced to the second and third dorsal ganglia. These rami are divided and the respective intercostal nerves followed into the intervertebral foramina. The dorsal root is divided proximal to its ganglion and the anterior root is divided intradurally. When these roots are divided, it is not unusual to tear or divide a segmental vein which passes through the foramen with the intercostal nerve, and considerable troublesome bleeding may arise from within the foramen. After the intercostal nerve has been removed, the dorsal sympathectic chain is isolated. Veins collateral to the superior intercostal and veins of the external vertebral plexus are frequently contiguous to the dorsal chain and often are intertwined with the rami. The dorsal chain is divided distal to the third dorsal ganglion and is dissected from the vertebra proximal to the second dorsal ganglion. The distal end is then sutured to the erector spinae muscle mass in an extracostal location. The lung is fully expanded during the closure of the wound. The wound layers are closed with fine suture material and a pressure dressing is applied.

It is apparent from this description that the wound is of considerable depth, ex-

posure is barely adequate, thin-walled veins are numerous, and, postoperatively, a potentially large extrapleural or intrapleural space results from the dissection. These conditions form the basis for possible complications which have not been described in the literature available to us. Complications have been encountered in our series, though some would not have been suspected if they had not been demonstrated by roentgenograms. Though none of the complications have been fatal, nor the postoperative course seriously affected, their potentialities should not be underestimated.

TYPE AND INCIDENCE OF COMPLICATIONS

Not all patients in this series have had routine postoperative roentgenological examinations, therefore the percentage of complications in the entire series cannot be stated. However, among the 66 patients operated upon, we have found 5 instances of resection of the fourth rib and 1 of resection of the second rib, instead of the third. Three patients developed extrapleural hemothorax; 2 developed postoperative atelectasis; 2 developed mediastinal emphysema; and 1 developed massive pneumothorax. Subcutaneous emphysema and small apical fluid levels believed due to accumulation of serum or blood, or both, in the extrapleural space, have been common findings postoperatively. The operations were performed by various members of the neurosurgical staff.

ROENTGENOLOGICAL EXAMINATION

Postoperative roentgenological examination should be a routine measure following dorsal sympathectomy. This procedure serves to detect any complications and to demonstrate whether the correct rib was resected. Patients with sizeable collections of blood in the extrapleural space may not exhibit any significant symptoms soon after operation. If roentgenological examination is not made, the optimum time for aspiration of this blood may elapse.

Posteroanterior and lateral views should be made routinely. Roentgenograms made with the Potter-Bucky diaphragm or with a stationary grid will often yield information not available on those made with the usual chest technique. This is particularly true if the effusion is confined to the upper portion of the thorax.

Differentiation of the extrapleural accumulation of fluid from effusion in the intrapleural space may at times be difficult, but the following points should be helpful in this differentiation: (1) in the erect position, extrapleural fluid does not collect in the costophrenic angle, (2) in the supine position, extrapleural fluid does not disperse as a diffuse shadow, but retains the same contour as in the erect position, and (3) a convex lower and anterior border is seen with the larger fluid collections. This resembles the shadow seen with encysted empyema but is usually confined to the upper posterior thorax. The clinical findings consistent with a large empyema collection are usually absent, and aspiration reveals the presence of blood.

The use of stereoscopic views and body section roentgenography is not indicated, as more information is gained from the posteroanterior and lateral views.

CASE REPORTS

Six case reports illustrative of complications of dorsal sympathectomy are given below.

Case 1. *Subcutaneous and mediastinal emphysema.*

A thirty-two year old soldier was operated on because of a diagnosis of thrombo-angiitis obliterans, quadrilateral. Right lumbar sympathectomy was performed on July 1, 1945, left lumbar sympathectomy on July 26, 1945, and right preganglionic dorsal sympathectomy on September 21, 1945. According to operative notes, the pleural space was not entered. Roentgenological examination on September 23, 1945, showed a collection of air along the left heart border and in the subcutaneous tissues of the right neck (Fig. 1). This air was readily absorbed and the postoperative course was uneventful except for moderate dyspnea.

Case II. *Apical extrapleural fluid.*

A twenty-six year old soldier was previously operated upon for injury to the left brachial plexus and aneurysm of the second portion of the left axillary artery. Because of persistently cold hands, a circular type of anesthesia, and fibrosis of the joints of the left upper extremity, dorsal sympathectomy was performed on September 10, 1945. The postoperative course was uneventful. Roentgenological examination of the chest on September 16, 1945, revealed a small extrapleural collection of fluid at the left apex. The left diaphragm was elevated (Fig. 2). The fluid was subsequently absorbed.

Comment. A small extrapleural fluid collection at the apex is commonly seen following dorsal sympathectomy. This fluid may consist of serum or blood, or both. Aspiration of small amounts is usually not necessary.

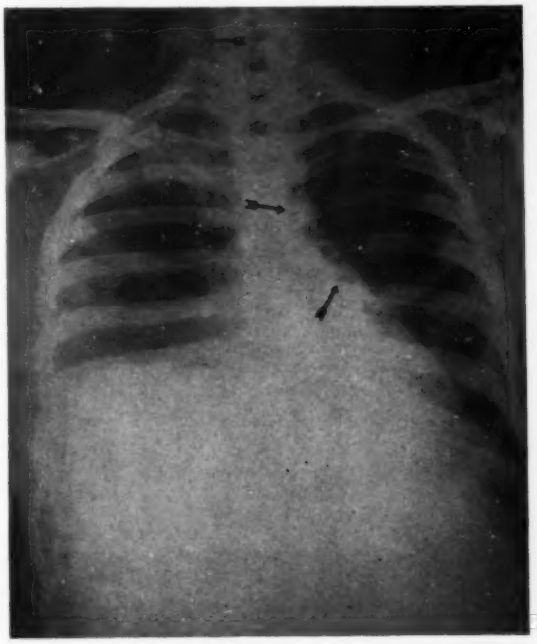

Fig. 1. Case I. Subcutaneous and mediastinal emphysema.

Case III. *Pneumothorax.*

A thirty-eight year old soldier was operated upon because of a diagnosis of thrombo-angiitis obliterans, severe, quadrilateral. Right dorsal sympathectomy was performed on September 6, 1945. No note was made that the pleural space had been entered but roentgenological examination of the chest on September 9, 1945, showed extensive right pneumothorax (Fig. 3). By September 22, 1945, the right lung was al-

Fig. 2. Case II. Small extrapleural collection at left apex. Arrow denotes fluid level.

Fig. 3. Case III. Massive pneumothorax.

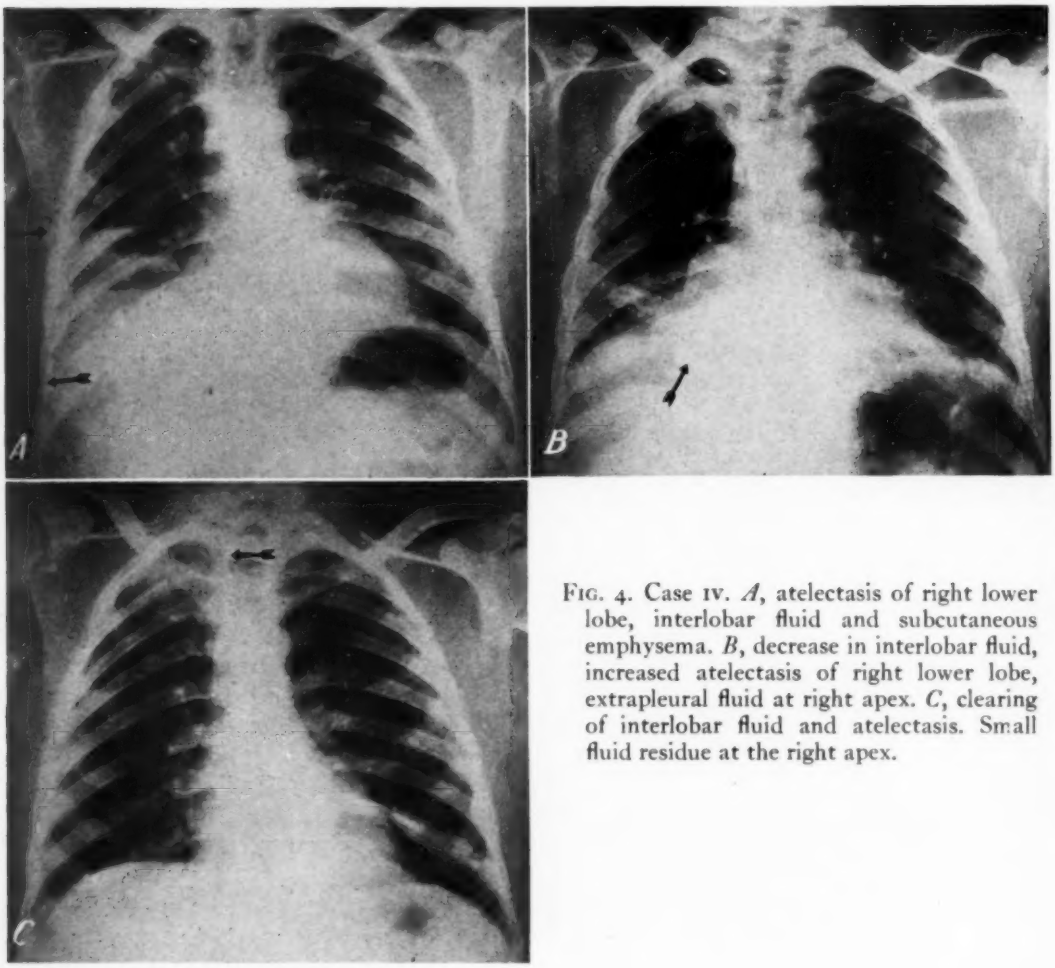

Fig. 4. Case iv. *A*, atelectasis of right lower lobe, interlobar fluid and subcutaneous emphysema. *B*, decrease in interlobar fluid, increased atelectasis of right lower lobe, extrapleural fluid at right apex. *C*, clearing of interlobar fluid and atelectasis. Small fluid residue at the right apex.

most completely re-expanded. Left dorsal sympathectomy on September 27, 1945, resulted in no pulmonary complications.

Comment. Massive pneumothorax may occur following dorsal sympathectomy. In the presence of cardiac or respiratory embarrassment, removal by a water-sealed needle and tube may be indicated; otherwise the air may be allowed to absorb spontaneously.

Case iv. *Atelectasis, pleural effusion, extrapleural fluid collection and subcutaneous emphysema.*

A twenty-three year old soldier was previously treated for a bullet wound of the right shoulder which produced injury to the brachial plexus and thrombotic occlusion of the right axillary artery. Following repair of the brachial plexus injury, the right hand remained cold and there was stiffness of the joints of the hand. Right dorsal sympathectomy was performed on September 28, 1945. The pleural space was definitely entered at this time. The patient experienced severe pleuritic pain postoperatively, and refused to cough or breathe deeply. Roentgenological examination of the chest on September 30, 1945, demonstrated partial atelectasis of the right lower lobe, fluid in the interlobar fissures, and a small area of subcutaneous emphysema of the right thoracic wall at the level of the tenth rib (Fig. 4*A*). Examination on October 1, 1945, revealed a decrease in the interlobar effusion but some increase in the atelectasis of the right lower lobe. A small extrapleural fluid collection with a fluid level was now noted at the right apex (Fig. 4*B*). On October 4, 1945, the interlobar effusion and the atelectasis had cleared

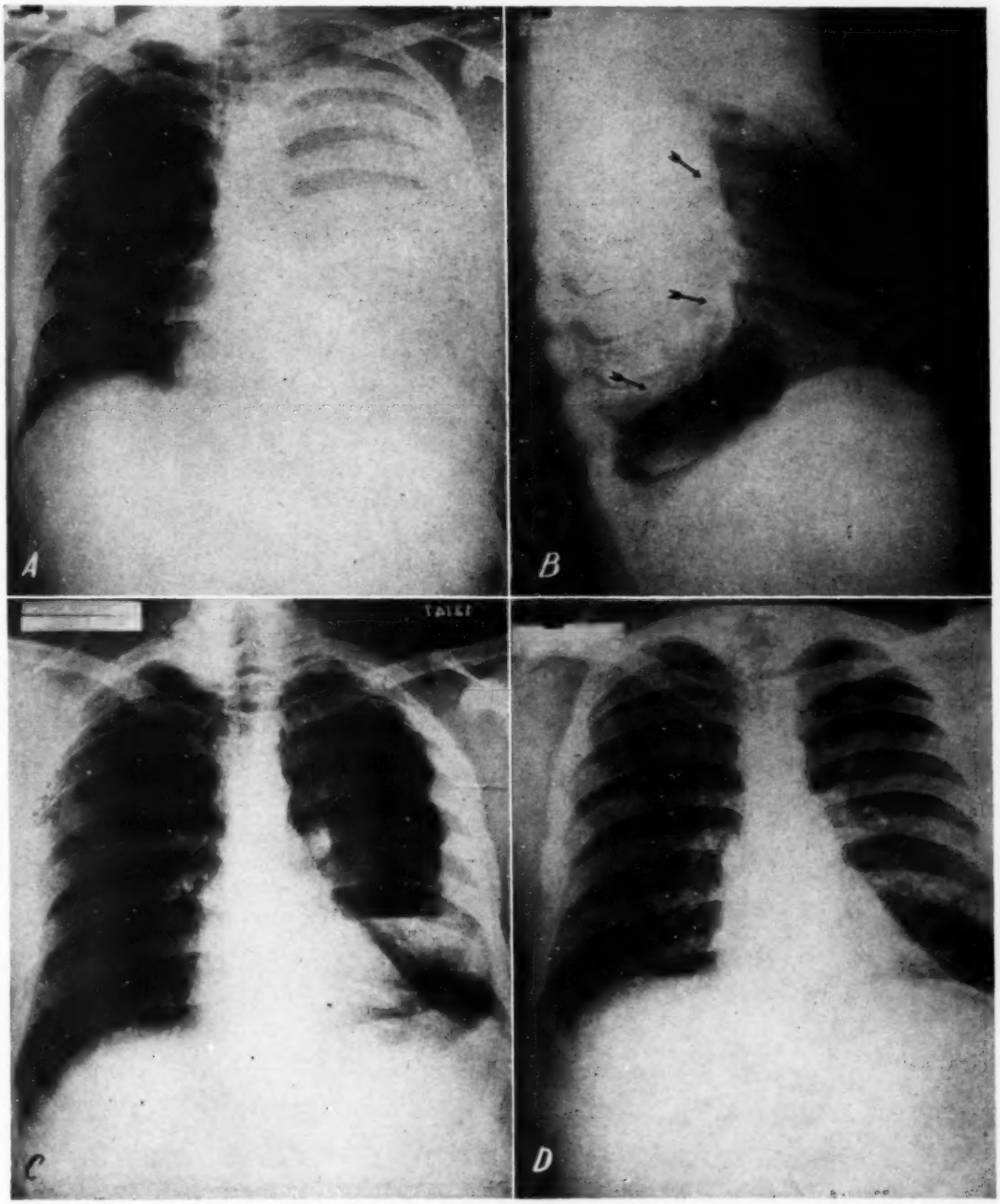

FIG. 5. Case v. *A*, extrapleural hemothorax. Fluid density covering almost entire left thorax in posteroanterior view. *B*, lateral view showing fluid collected along posterior chest wall. *C*, film after aspiration of 1,350 cc. of blood. *D*, fluid absorbed, seven months after sympathectomy.

but a small amount of apical extrapleural fluid remained (Fig. 4*C*). No further complications were encountered.

Comment. This patient presents four of the complications of dorsal sympathectomy: extrapleural fluid collection, interlobar effusion, atelectasis, and subcutaneous emphysema.

CASE V. *Extrapleural hematoma.*

A twenty-eight year old soldier was admitted

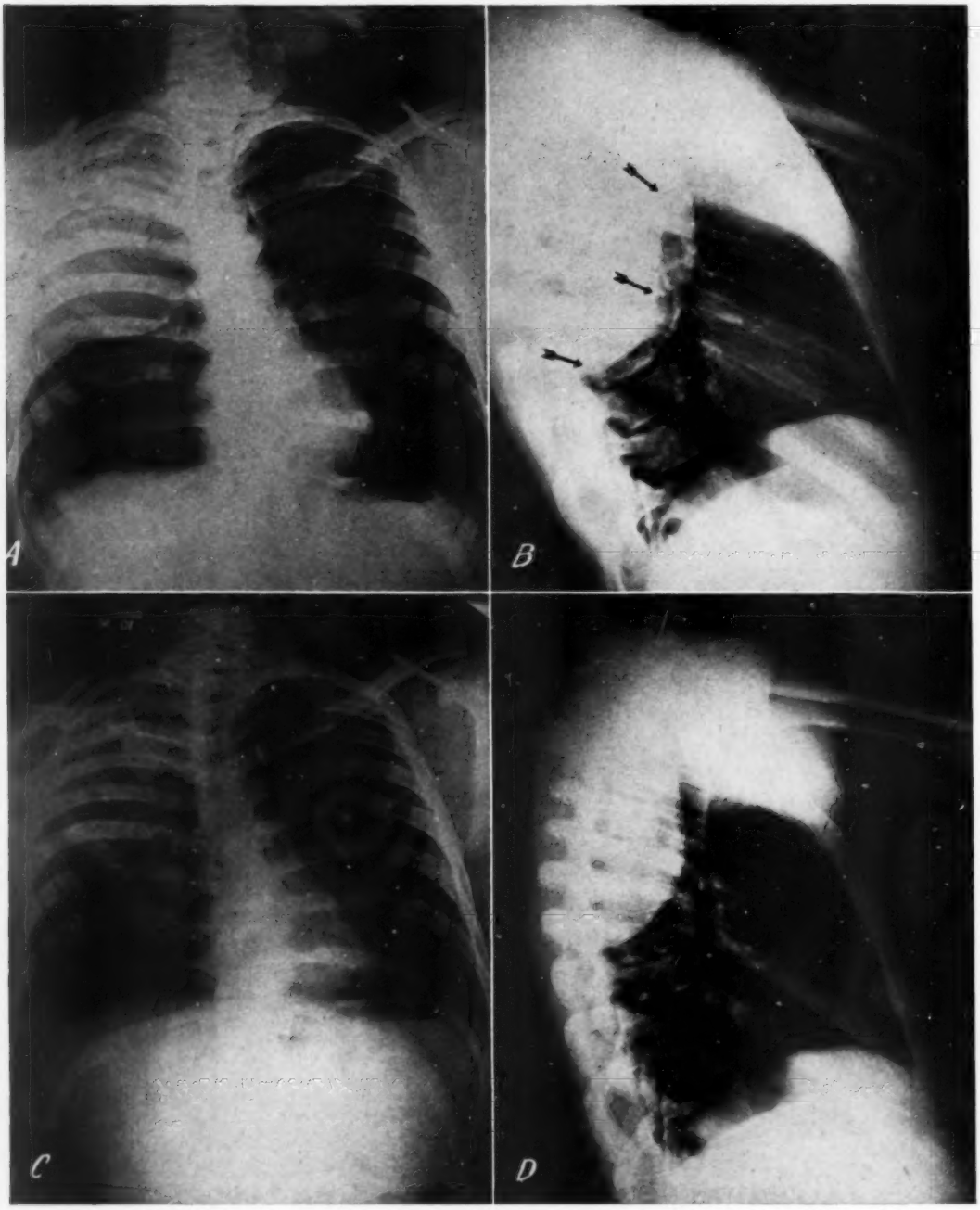

Fig. 6. Case vi. *A*, posteroanterior view three days after sympathectomy. Density over right upper thorax resembles lobar pneumonia. *B*, lateral view showing extrapleural fluid collection. *C*, film after aspiration of partly clotted blood. Removal incomplete. *D*, lateral view after partial aspiration. Note decrease in extent of fluid collection.

because of cold hands and abscesses at the finger tips. Right dorsal sympathectomy was performed on February 1, 1945, using a combined muscle splitting and muscle cutting approach. The postoperative course was uneventful. On March 12, 1945, left dorsal

sympathectomy was performed, using the Smithwick incision. A small hole was torn in the pleura beneath the third rib but the lung was kept expanded by positive pressure. There was no note of unusual bleeding at the time of operation. On March 14, 1945, two days after operation, the patient exhibited respiratory difficulty and percussion revealed dullness over the left thorax posteriorly. Roentgenological examination showed a fluid density extending over almost the entire left chest but with no shifting of the heart and mediastinum. A small area at the left apex was unfilled by fluid (Fig. 5*A*). Lateral view showed a dense fluid collection along the posterior chest wall with convex anterior and lower borders (Fig. 5*B*). On March 17, 1945, 6,500 cc. of old blood was aspirated from the left thorax. On March 19, 1945, 400 cc. of the same material was removed by aspiration, and on March 30, 1945, 300 cc. Roentgenological examination on April 10, 1945, demonstrated a fluid level in the left thorax which extended up along the lateral chest wall but there was evident decrease in the amount of fluid (Fig. 5*C*). Examination on September 8, 1945, showed that all fluid had been absorbed and there was only slight pleural thickening (Fig. 5*D*).

Comment. This case illustrates the possibility of a large extrapleural hemothorax by bleeding from vessels whose damage was not noted at the time of operation. Lateral view was helpful in determining the limits occupied by the accumulated blood and in distinguishing from massive pleural effusion. The blood was successfully removed by repeated aspiration.

Case vi. *Extrapleural hemothorax.*

A thirty-two year old soldier received a bullet wound of the right clavicular region with resulting fracture of the clavicle and injury to the brachial plexus. Following repair of the brachial plexus injury, there was persistent burning pain in the right hand. Dorsal sympathetic block completely relieved the pain, and right dorsal sympathectomy was performed on September 6, 1945. There was no unusual febrile course, but patient complained of pain in the right upper chest. Roentgenological examination on September 9, 1945, revealed a large extrapleural fluid collection along the right posterior thoracic wall (Fig. 6, *A* and *B*). About

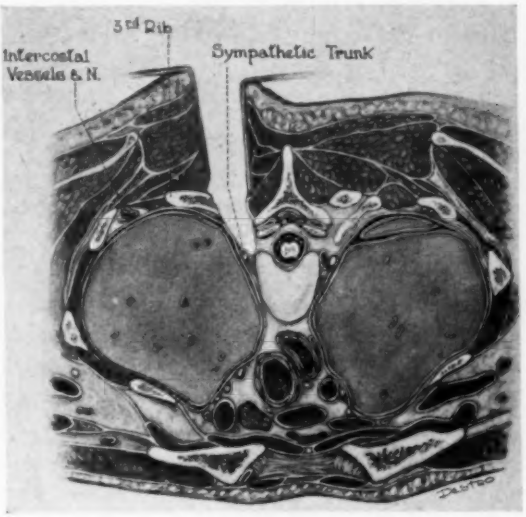

Fig. 7. Incision exposing sympathetic chain at level of third dorsal vertebra.

150 cc. of dark clotted blood was aspirated on September 14, 1945, but considerable fluid remained (Fig. 6, *C* and *D*).

Comment. In this instance, the patient's complaint of pain led to roentgenological examination and discovery of the extrapleural hemothorax. However, pain may not be a prominent symptom, and for this reason, routine postoperative roentgenograms should be made.

SUMMARY

1. The anatomy and surgical procedure of dorsal sympathectomy have been briefly reviewed.

2. Extrapleural hemothorax, pneumothorax, pleural effusion, atelectasis, and mediastinal emphysema are the most frequent complications of dorsal sympathectomy. Extrapleural hemothorax is the most serious of these complications. Aspiration should be carried out early.

3. The roentgenological examination and diagnosis of extrapleural fluid collections is discussed.

4. Six cases are reviewed and the roentgenological findings illustrated.

5. Routine roentgenological examinations of the chest should be made within a few days after dorsal sympathectomy.

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WEBS AND CONSTRICTING BANDS IN THE UPPER ESOPHAGUS (SIDEROPENIC DYSPHAGIA)*

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WHILE the roentgenological literature is replete with articles on atresias, strictures, diverticula and other pathological conditions involving the esophagus, practically no mention is made of esophageal webs, or, what is apparently a similar entity, narrow constricting bands in the upper portion of the esophagus. This seems rather unusual in view of the statement by Macmillan[6,7] who, reporting on the roentgenological findings in a series of 1,600 patients complaining of dysphagia, found esophageal webs in 13 per cent of those cases in which there were positive findings, other than foreign bodies, accounting for the dysphagia. Waldenström and Kjellberg[15] state that this malady is beyond question the most common disease of the gullet. For example, in 1938 when they were searching carefully for these lesions they found 26 cases and, in the first half of 1939, they found 12 cases. In our experience, and I might add in the experience of laryngologists and other roentgenologists with whom I have spoken, the finding of esophageal webs or bands has been rare. This may be due to the fact that we have not been sufficiently familiar with this entity and have not been on the alert to recognize changes due to this condition.

The lesions to which we refer may be either thin membranous webs which sweep partially across the lumen of the esophagus, or narrow bands which encircle the esophagus constricting the lumen. Macmillan states that they invariably occur above the suprasternal notch. The favorite location is in the postcricoid area. Blood examination generally reveals an anemia of the hypochromatic type. Other changes which may be found are fissures at the corners of the mouth, glossitis, koilonychia, achlorhydria or hypochlorhydria and enlarged spleen. The disease is predominantly one of adult women.

CLINICAL ASPECTS

The clinical symptoms are quite typical. Depending on the degree of the obstruction caused by the band or web, there are varying degrees of dysphagia. Some patients may note only that they must eat more slowly and chew their food more thoroughly than other people. They may require an hour to eat a meal. With rapid eating and drinking the food and liquid tends to dam back and, since the obstruction is high in the esophagus, overflows into the trachea resulting in severe paroxysms of choking and strangulation. Those with a more pronounced degree of obstruction must limit their diet to liquids or very soft foods. To these persons, eating becomes a dreaded ordeal. They can no longer eat in public and may on account of the frequency with which the food is regurgitated during a paroxysm of choking and strangulation, be forced to eat their meals over a wash bowl.

The diagnosis which is usually made is esophageal spasm, globus hystericus or some other neurosis. The patients, accepting this opinion and being unable to obtain relief, may continue to suffer for years.

ETIOLOGY

The cause of these bands or webs is not definitely known. J. Payson Clark,[1] who in 1911 reported the first case of web in the upper esophagus of which we can find record in the American literature, referred to the lesion as a congenital web of the esophagus. Mosher[9,10,11] was of the opinion that while some were congenital, others were due to scar tissue forming after some abrasion of the mucosa either as the result of trauma or infection. Kelly[4,5] noted that most of the

* From the Radiological Group of Drs. Hill, Thomas, Farmer, Sackett and Schumacher, Cleveland, Ohio.

patients were women. Some of them gave histories of long periods of anemia, dyspepsia and impaired general health preceding the onset of the dysphagia. A fair proportion, however, felt that the dysphagia was primary and the disturbance of nutrition and nervousness was secondary. He also noted that in some of the cases the mucous membranes were pale and waxy and the tongue was smooth and devoid of papillae. Cracking in the corners of the mouth was observed and believed to be due to increased salivation. He excluded hysteria as a cause and suggested that the spasm might be due to a disturbance in balance between the Meissner and Auerbach gangliated plexuses. Paterson[12] also noted the association of spasmodic dysphagia and superficial glossitis occurring chiefly in women. Vinson[14] reported a series of 69 patients in which there was an association of dysphagia, secondary anemia and enlargement of the spleen. Roentgenographic and esophagoscopic examination failed to show any organic lesion. Since the patients improved after plain bougies were passed which caused no real stretching, he felt that the dysphagia was hysterical in origin and the anemia and enlarged spleen were due to prolonged unbalanced diet. Moersch and Conner[8] reported a series of cases, all of whom were women in which there was an association of dysphagia, anemia, large spleen, atrophic mucous membranes, cracking of the corners of the mouth and achlorhydria. Since they were unable to demonstrate roentgenologically or otherwise any organic lesion, esophageal membranes or webs, and since psychic reassurance played an important part in the treatment, they concluded that the dysphagia was hysterical in origin and the anemia and other changes arose from a prolonged unbalanced diet. Suzman,[13] referring to the relationship of anemia, glossitis and dysphagia, pointed out that all of the manifestations of this syndrome, except for the dysphagia, were indistinguishable from those of idiopathic hypochromic anemia, and he believed that the esophageal lesions and the consequent dysphagia were the result of an extension to the esophagus of the same pathological changes noted in the mouth and tongue. He also felt that it was not improbable that the anemia and thus, of the syndrome glossitis, dysphagia and anemia was in the nature of a deficiency dependent on a gastric abnormality. Hoover[3] concluded that the atrophic processes associated with the anemia predisposed to web formation and fibrosis but pointed out that many cases which have the anemia do not have dysphagia and that in others webs and fibrosis may be present without anemia. Waldenström and Kjellberg also conclude that the dysphagia is simply a symptom of essential hypochromic anemia and have termed it sideropenic dysphagia. They state further that this form of dysphagia is always improved or cured with an intense and prolonged iron treatment. Holmgren[2] also felt that various manifestations of this syndrome were due to iron deficiency.

One would conclude from this review that the primary cause is a deficiency of iron. The other changes which may or may not be present, such as enlarged spleen, glossitis, cracking in the corners of the mouth, koilonychia, esophageal webs or bands, and hense the dysphagia are secondary to the hypochromic anemia.

RELATIONSHIP TO CANCER

The possible relationship between the epithelial changes due to hypochromic anemia and the development of cancer has been stressed by several authors. In several cases which have been reported cancer developed in the mouth or throat at sites separate from the esophageal webs. Case 1 in our series developed metastatic carcinoma in the glands of the neck. The primary lesion was never found but since there was no recurrence of symptoms referable to the esophagus over a fifteen month period between the discovery of the esophageal web and the development of the metastatic glands, it is reasonable to assume that the esophageal lesion was not

the source of the carcinoma. Suzman, in a case of esophageal web which came to autopsy, found immature cells exhibiting mitosis and changes in the mucosa simulating leukoplakia. He felt that these changes were of interest in view of the fact that in another case of his series, cancer developed at the side of the tongue. One patient of ours (not included in this series), now under treatment for squamous cell carcinoma of the upper esophagus, gave a clear-cut history of severe dysphagia associated with anemia for a period of years. Her blood findings in 1929 were, red blood cell count 4,380,000, hemoglobin, 33 per cent, and gastric analysis revealed an achlorhydria. During the intervening years she has received treatment for the anemia intermittently, with favorable response while under treatment. Her last relapse was three years prior to the onset of her present symptoms which led to the diagnosis of carcinoma.

ROENTGEN EXAMINATION

The demonstration of these constricting bands or webs by roentgen methods requires a somewhat specialized technique. In the cases we are reporting the usual roentgenoscopic examination with thin and thick barium mixture was insufficient to make the diagnosis, since the passage of the meal through the upper esophagus was too rapid to allow more than fleeting glimpses of the indentation caused by the band or web. However, roentgenograms made with rapid exposure immediately after the patient swallows a large mouthful of barium mixture showed the constricting band or web in an otherwise distended esophagus. The esophagus must be distended, since if it is empty or only partially filled, one may find no evidence of any abnormality and, furthermore, the mucosal pattern may appear perfectly normal.

Of great value was the use of barium-filled capsules. Under roentgenoscopic examination the location of the obstruction could be readily seen but detailed study was unsatisfactory on account of movement due to choking and gagging occasioned by the stoppage of the capsule. Here again roentgenograms made with rapid exposures clarified the condition showing the capsule lodged against the band or web, the latter being sometimes outlined by air in the esophagus above and below the constriction.

Final proof of the presence of a band or web by visualizing it through the esophagoscope may not be obtained unless the esophagoscopist takes particular care in inserting the scope. The lesion is very high in the esophagus and may readily be broken down before it is observed, leaving no evidence remaining other than possibly a faint tear in the mucosa.

REPORT OF CASES

Case 1. Mrs. M., aged sixty-two, was referred to us for examination of the esophagus on October 20, 1942. She stated that she had had increasing difficulty with swallowing for the past four years. This became quite severe during the past year and a half. Her diet was limited to soft foods. Heavier foods caused severe choking with frequent regurgitation. This became so severe that she could no longer eat in restaurants or in company with friends. Her condition had been diagnosed on several occasions as esophageal spasm, neurosis, and hysteria. She gave no history of any prior illness other than childhood diseases and she knew of no injury to the esophagus.

The patient was thin but appeared to be in good health. Nothing remarkable was noted in the appearance of the tongue or mucous membranes. Anemia was not suspected but the blood examination showed an erythrocyte count of 4,040,000 and hemoglobin 61 per cent.

Roentgenoscopic examination showed that thin and thick barium mixtures passed readily through the esophagus and nothing abnormal was noted. A .00 capsule filled with barium was then given. This caused such severe choking that roentgenoscopic examination was unsatisfactory except to show that the capsule lodged in the postcricoid area until it was finally regurgitated. Preparation was then made to make roentgenograms during the swallowing of the capsule. The first capsule swallowed, however, passed through the esophagus with no delay. Another one was given and this time the

FIG. 1. Case I. The barium-filled capsule is lodged in the postcricoid area and a faint shadow of a constricting band can be seen outlined by air in the esophagus above and below it.

capsule again lodged in the postcricoid region and we were able to obtain several roentgenograms before the capsule was regurgitated.

Examination of the roentgenograms showed the lower end of the capsule resting against a narrow web in the postcricoid region which partially obliterated the lumen of the esopahgus. No alteration in the contour of the esophagus other than this web could be seen.

The patient was operated upon and the obstruction was removed by making radial incisions in the web and dilating the esophagus with the scope.

Following this operation the patient had complete relief and was able to eat as rapidly as other individuals. However, on February 4, 1944, she returned to the hospital with the complaint of a large cervical gland just below the left ear. The possibility of carcinoma involving the tonsil was considered. The left tonsil was removed and a section was removed from the right tonsil. The pathological report was "lymphoid hyperplasia, and chronic and acute inflammation of the tonsils." The gland was later removed and partially differentiated squamous cell carcinoma was found. The patient later died from carcinoma. The primary tumor was never located.

Comment. This case is of interest because of the development of metastatic carcinoma in the cervical glands. Since there was never any recurrence of dysphagia, we do not believe that the lesion in the esophagus was carcinomatous. It seems more probable that the growth was in the mouth or nasopharynx. The possible relationship between epithelial changes due to iron deficiency and the development of cancer is emphasized.

CASE II. Mrs. S., aged thirty-six, was referred to us on September 1, 1944. She stated that her difficulty in swallowing started suddenly after choking on a piece of egg in 1939. Since that time food would tend to lodge in the throat. On account of the constant fear of choking, she limited her diet to soft foods and would eat slowly, taking at least an hour to eat a meal. She had been told on several occasions that her trouble was due to nervousness and that there was nothing abnormal in the throat. She had no complaints other than the dysphagia. No blood examination was done at this time. However, on June 25, 1946, an examination showed an erythrocyte count of 4,890,000, hemoglobin 88 per cent.

Roentgenoscopic examination using thin and thick barium mixtures was insufficient to make a diagnosis. A .00 barium-filled capsule was given to the patient. This lodged in the postcricoid area and caused severe choking until it was regurgitated. Roentgenograms made with rapid exposure showed a constricting band outlined by air in the esophagus above and below it and the capsule resting against this narrow orifice. Roentgenograms made immediately after swallowing a large mouthful of barium showed the concentric narrowing in the barium column.

Esophagoscopy failed to show any web or constricting band, but it was noted that, when the esophagoscope was withdrawn, there was a slight amount of bleeding in the postcricoid area.

There was immediate relief from the dysphagia after the operation. Re-examination by roentgen ray showed nothing abnormal. A com-

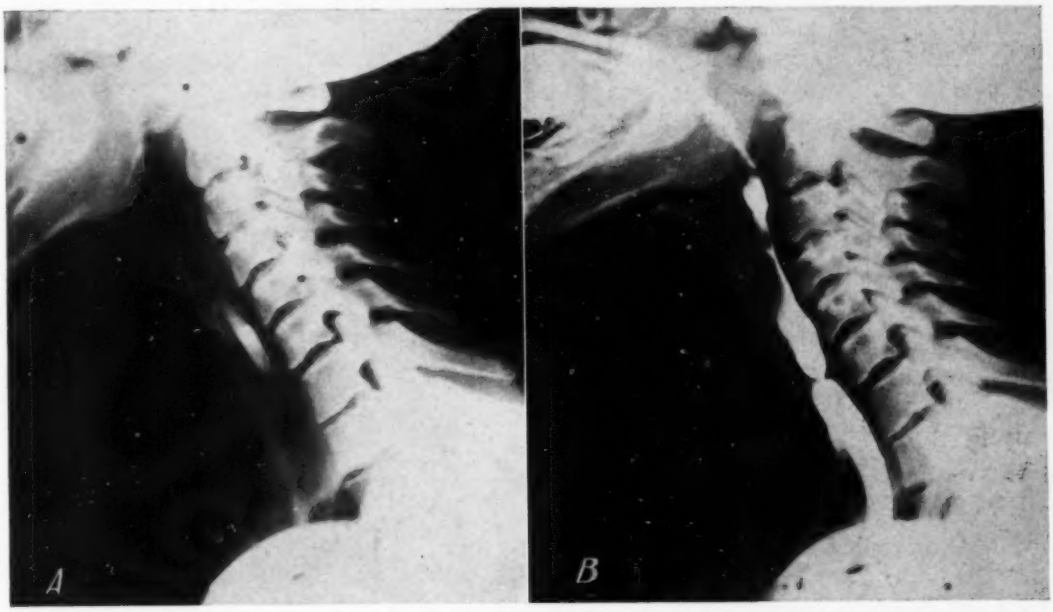

FIG. 2. Case II. (*A*) The barium-filled capsule is lodged in the postcricoid area. (*B*) A constricting band is shown in the well filled esophagus.

munication on June 25, 1946, stated that there has been no recurrence of the dysphagia.

Comment. This case illustrates that the constricting band can be easily dilated during esophagoscopy before it is visualized leaving no evidence remaining of where the lesion had been other than the slight tear in the mucosa.

CASE III. Miss D., aged thirty-nine, was referred to us on November 20, 1944. She stated that she had had difficulty with swallowing for ten years. This had become more severe until her diet was limited to liquids or soft foods. Unless she was careful she would have violent spells of choking. If she went to a restaurant she had to limit her diet to liquids.

Her past history was irrelevant. Except for the dysphagia, she had no complaints. Her health general was good. She stated that she had noted cracking in the corners of the mouth for several years. The appearance of the tongue suggested some papillary atrophy. Blood examination showed an erythrocyte count of 3,340,000 and hemoglobin below 50 per cent.

Here again roentgenoscopic examination with thin and thick barium mixtures was not satisfactory to demonstrate the lesion. A .00 capsule filled with barium was observed under roentgenoscopic observation to lodge in the postcricoid area causing severe choking. Roentgenograms made with rapid technique showed the capsule lodged in the postcricoid region but did not show any web. However, roentgenograms made with rapid technique immediately after swallowing a large mouthful of thick barium mixture showed a pronounced incisura in the anterior surface of the barium column indicating an esophageal web.

Esophagoscopic examination revealed the web as an almost transparent veil sweeping across the anterior half of the eosphagus in the postcricoid area. Sections of the web were removed by biting forceps but, owing to the extreme thinness of the tissue, complete removal was impossible. The esophagus was then dilated by the esophagoscope.

Following the operation she had complete relief from the dysphagia. Re-examination by roentgen ray showed no delay in the passage of the barium-filled capsule through the esophagus and the roentgenograms of the filled esophagus showed only traces of the web remaining. According to a recent communication she has had no recurrence of the dysphagia.

CASE IV. Mrs. B., aged forty-six, was referred to us on June 1, 1945. She stated that she first noticed difficulty with swallowing after choking on a piece of chicken about a year previously.

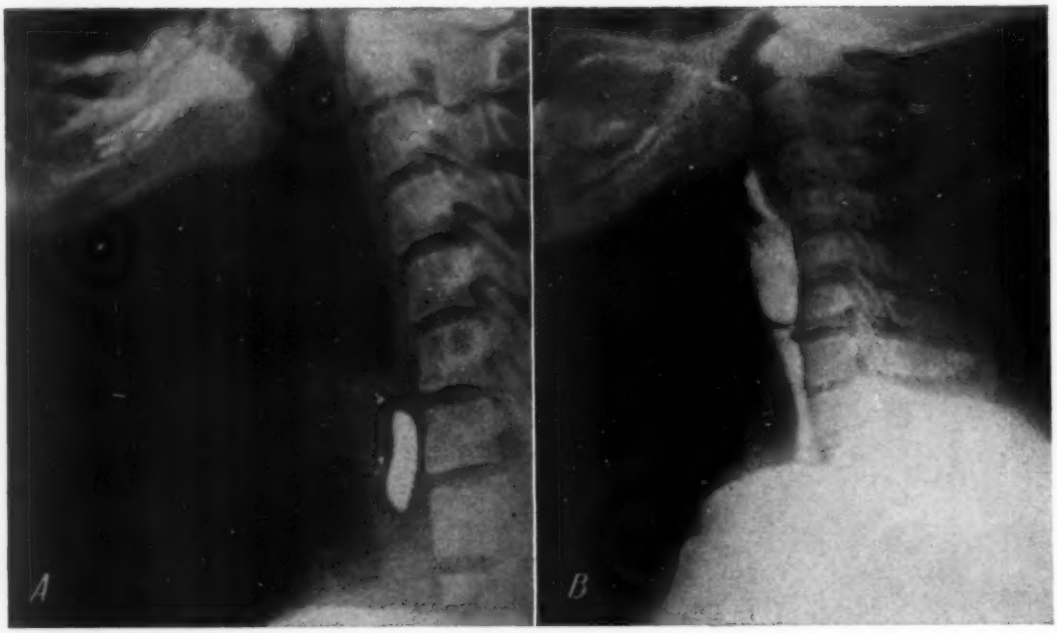

FIG. 3. Case III. (*A*) The barium-filled capsule is lodged in the postcricoid area. (*B*) A membranous web is shown which almost obliterates the lumen of the esophagus.

Her diet was limited to liquids or well masticated foods. It would frequently require an hour to eat a meal.

Her past history was irrelevant and her present health was good. She had lost about 10 pounds due to her limited diet. Blood examination at this time showed an erythrocyte count of 3,320,000; hemoglobin 61 per cent. She stated that she had noted a tendency toward cracking in the corners of the mouth for years. The

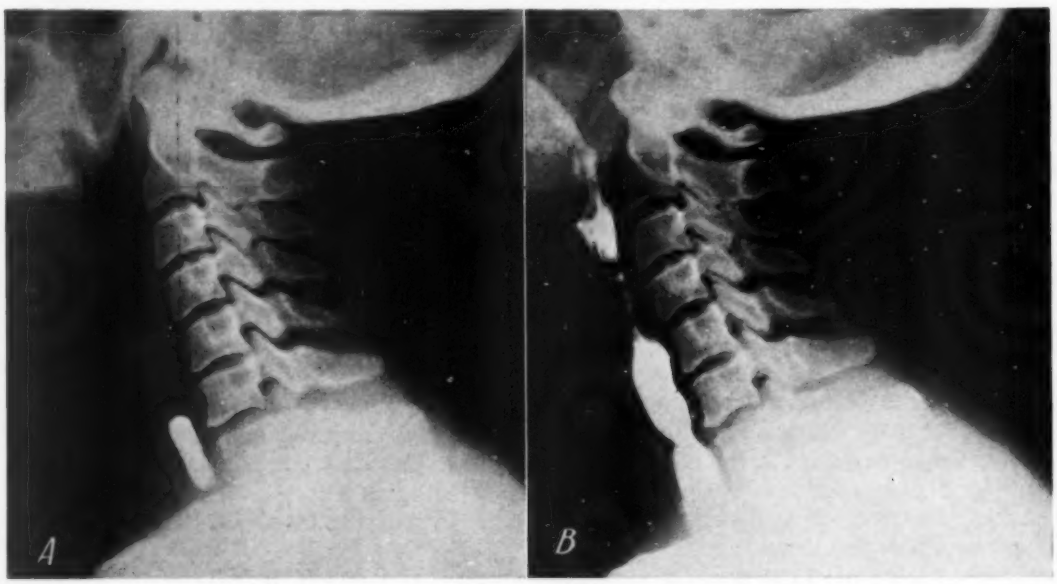

FIG. 4. Case IV. (*A*) The barium-filled capsule is lodged opposite the lower border of the seventh cervical vertebra. (*B*) A constricting band is shown in the distended esophagus.

tongue and mucous membranes did not appear abnormal. Her finger nails were slightly brittle but not deformed. There was no enlargement of the spleen.

As in other cases, the usual roentgenoscopic examination was not very helpful. However, roentgenographic examination with the barium-filled capsule and with thick barium paste showed a constriction in the postcricoid region.

Esophagoscopy revealed nothing abnormal other than the constriction. This was readily dilated by the esophagoscope.

Following the operation the patient had complete relief for about nine months when she again began having difficulty with swallowing. During this time she had received no treatment for the anemia. Re-examination on May 6, 1946, showed that the constricting lesion was slightly broader than before. Intensive iron therapy following this examination failed to influence the dysphagia, so the esophagus was again dilated. Relief from the dysphagia was again obtained.

SUMMARY

Dysphagia, often diagnosed as being due to globus hystericus or other neurosis, may be due to webs or constricting bands in the upper esophagus. This condition is found with few exceptions in women and is often associated with essential hypochromic anemia. The pathological changes in the esophagus, as well as other changes which may be noted in these cases, such as glossitis, cracking in the corners of the mouth and koilonychia, may be due to a deficiency of iron.

The webs and constricting bands in the esophagus may be demonstrated in roentgenograms made with rapid technique after having the patient swallow a barium-filled capsule or immediately after swallowing a large mouthful of barium mixture so as to show the upper esophagus well filled.

The possibility of a relationship between the epithelial changes found in the syndrome and the development of cancer is noted.

The treatment consists of dilation to relieve the dysphagia and large doses of iron continued over a long period of time.

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CARCINOMA OF THE PANCREAS WITH GENERALIZED BONE METASTASES

REPORT OF TWO CASES

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REPORT OF CASES

CASE I. The patient was a white male, aged forty-five, whose complaints were fatigue, backache, dyspnea, of six months' duration. Several days before admission he had suffered severe, generalized, influenza-like aching, with perspiration, and he had been jaundiced for a short time. Physical examination was negative except for the blood picture, which showed a leukocyte count of 6,500 and an erythrocyte count of 2,800,000. We had made a gastrointestinal roentgen study six months previously, which was negative. At this admission the referring clinician sent the patient to us with this note: "This man has severe backache and epigastric pain. If the gallbladder x-rays are negative, please make any other studies which you think are indicated."

Cholecystographic studies of the gallbladder showed normal functioning without stones. The ribs, as shown in these cholecystograms, were mottled by metastatic lesions and further investigation revealed a diffuse involvement of the pelvis and entire spine by an osteoplastic type of tumor metastasis (Fig. 1 and 2). No lesions were visible in the skull tables, but the sphenoid bone was mottled. These changes were regarded as being metastatic from carcinoma of the prostate. Blood chemistry showed a serum alkaline phosphatase of 50.9 Ka units. Serum acid phosphatase, 2.6 Ka units. The second examination showed a serum alkaline phosphatqse of 4.65 Ka units and serum acid phosphatase 5.0 Ka units. Amylose determination from the blood serum was 2.24. No Bence-Jones protein was found. A normal prostate was palpable.

On April 16, 1945 a barium meal study revealed the following findings (Fig. 1): "The greater curvature of the antrum is displaced upwards, the duodenal bulb is attenuated and the loop is distended, all as evidence of tumor in the region of the head of the pancreas. Inasmuch as the mucosa throughout these areas is intact it would seem that no infiltration has taken place."

The patient died on May 2, 1945. The autopsy report was given by Dr. W. O. Russell. Carcinoma involving the head and body of the pancreas and lesser curvature of the stomach was given as a primary cause of death. "The pancreas is identified with difficulty due to the large mass of tissue previously noted in the root of the mesentery. This mass extends into the retroperitoneal tissues behind the pancreas to involve the first part of the duodenum and the head of the pancreas. The stomach is involved in its distal part; it is estimated that the involvement is 7 cm. from the pyloric end of this organ. A section of tissue in this region reveals a racemose gray-white surface in which there appears to be an increased amount of negative tissue. The pancreatic ducts are not found." Bone marrow: "A section taken through a lumbar vertebra shows a marked change in this spongy bone. It is unusually firm and has a gray-white-pink color in contrast to the deep pink-red color usually seen; it is difficult to cut this bone, particularly in the region of the foci of the gray-white color. This type of pathologic change is noted in all of the lumbar vertebrae which are open."

Dr. Russell's concluding comment in his pathologic protocol is of interest. "This is an interesting case since it is an example of carcinoma of the head of the pancreas that has metastasized to bones and produced an osteoblastic type of change. This, in my opinion, is extraordinarily rare; I do not recall ever having seen such a case. There can be no doubt of this being a primary carcinoma of the head of the pancreas with metastasis to the bone marrow."

CASE II. The patient was a white male, aged twenty-seven, of Czecho-Slovakian ancestry. He had been entirely well until two and one-half months prior to admission. At that time he had first noted severe epigastric and lower sub-

sternal pain, sharp in character, lasting about an hour, which was relieved by eating or by vomiting. The latter symptom was persistent until about the third week. He ate well during this period, but he had lost about 20 pounds in weight between the onset and the time of his admission. There was no other contributary past history and it was with this series of complaints that the patient was admitted to the hospital.

On physical examination there were no findings except the suggestion of weight loss which was consistent with the history. There were no localized abdominal findings and the general physical examination was entirely negative.

The laboratory studies revealed a definite gastric retention on analysis with a normal chemical content. The urinalysis was normal and the blood count showed a hemoglobin of 12.5 grams with an erythrocyte count of 4,590,000 and a leukocyte count of 6,550, with a normal differential.

The gastrointestinal series was done on the fourth day after admission. At that time the chest and esophagus were noted as normal. The stomach contained considerable semifluid residue.

Fig. 1. Case 1. Stomach and duodenum immediately after barium meal showing distended duodenal loop and osteoplastic bone metastases.

Fig. 2. Case 1. Showing vertebral involvement.

On the pyloric aspect of the antrum (Fig. 3) a constant filling defect was found, concave in type and fairly smooth with a narrowed pyloric channel arising in its pattern. It contained a constant niche or ulcer crater at the rim of the pylorus which was at least 1.0 cm. in diameter. The duodenum was deformed and narrowed for a distance of about 2 inches and there was moderate point tenderness in this region. The surrounding structures were found to be fixed so that there was no mobility on palpation. At six hours there was a 75 per cent gastric residue and there was still some barium staining in the

FIG. 3. Case II. Showing persistent deformity in the gastric antrum.

stomach at twenty-four hours. The conclusion at that time was that there was a stenosing pyloric or prepyloric lesion which could well be a neoplasm.

Despite repeated lavage a large gastric retention was apparent for the succeeding two months. Two subsequent gastrointestinal studies confirmed the previous impression of a stenosing lesion in the distal stomach and indicated a persistent high gastric retention.

The patient was prepared for surgery and a gastroscopy was done which failed to locate any lesion on the gastric side of the pylorus. The patient was given a transfusion and under spinal anesthesia supplemented with pentathol and nitrous oxide-oxygen the upper abdomen was inspected. A mass the size of a small egg was found involving the intrinsic structures and upper portion of the duodenum. It was firmly adherent to the head of the pancreas. A partial gastrectomy was done and approximately 65 per cent of the stomach was removed using a posterior Polya operation with a Hofmeister modification. The operation was without incident and the patient was returned to his room in good condition. His postoperative course was uneventful. Within three and one-half weeks he was on a fairly complete diet.

About one month after surgery he began to complain of low back pain but nothing remarkable was found on examination and physiotherapy was instituted. On the twenty-ninth postoperative day the patient left the hospital and visited friends. On returning after a few hours away from the hospital he complained of not feeling well and reported that he had noted blood in his urine. This was confirmed by laboratory study. Two days later a cystoscopic study revealed that there was bilateral bleeding through the ureteral orifices. Retrograde pyelography revealed some substance displacing the dye on the left while the right kidney was quite normal. On that day slight bleeding from the gums was noted and the laboratory findings showed an erythrocyte count of 4,090,000 with a hemoglobin of 11.6 grams and a leukocyte count of 11,350 with 75 per cent polymorphonuclears. The clotting time was eight minutes and the bleeding time was six and one-half minutes. The platelet count was 70,000. The patient was immediately placed on a high vitamin diet with medication to correct the prolonged bleeding and clotting time. A blood transfusion was given but new sources of bleeding appeared, namely in the stools and at the site of venipuncture for the transufsion. The platelet count rapidly dropped to 20,000 and the patient began to bleed by emesis.

Five weeks after surgery the patient complained of a severe headache and backache, and within a few minutes he had had a severe convulsion with twitching of the facial muscles and frothing at the mouth. His pulse became rapid and thready. This was followed by a period of unconsciousness from which he never recovered. Blood taken at this time showed a prothrombin level of 30 per cent of normal. Despite parenteral hykinone intramuscularly and repeated transfusions the patient died twenty-four hours later.

Pathological Findings. The resected stomach revealed an adenocarcinoma, grade 3, of the stomach, arising in and about an ulcer crater of the pylorus. There were multiple ulcers in this region and the mass was seen to extend beyond the gastric wall. At postmortem the operative site in the stomach was found to be clean and there was no evidence of abnormality in the stomach or duodenal remnant. The head of the

pancreas was found to be hard and indurated to palpation, and there was one discrete nodule on its anterior margin, gray in color, which appeared to be tumor tissue. It was noted that the tumor nodule in the head of the pancreas was in truth tumor and the greater portion of the head of the pancreas was so replaced. Sections of the lung tissue microscopically revealed numerous small nests of hyperchromatic neoplastic cells in the small and medium-sized arteries, as well as in many of the arterioles and capillaries in the alveolar walls. The tumor nodule in the liver showed similar neoplastic growth and the same was true of the lymph nodes of the peri-aortic region. Sections of bone marrow from the ribs and vertebral column showed large areas in which the hemopoietic tissue had been nearly entirely replaced by neoplastic growth similar to that found in the head of the pancreas. The discussion by the pathologist indicates that the primary neoplasm was pancreatic in type, extending to the stomach as either a metastatic growth or by direct contiguity.

Death had resulted from an extensive cerebral hemorrhage which had ruptured into the ventricles. Bleeding of an extensive type was presumably accounted for on the basis of the bone metastases with a thrombocytopenia. This was considered an unusual example of metastasis to the bone marrow and generalized throughout the body from a primary carcinoma of the pancreas.

SUMMARY

Two cases of pancreatic carcinoma are reported, both having diffuse bone metastases, one of osteoplastic type, the other showing an extensive destruction of the bone marrow.

SICKLE CELL ANEMIA

CASE REPORT WITH UNUSUAL ROENTGEN FINDINGS*

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SICKLE cell anemia, first described by Herrick[17] in 1910, is known to affect chiefly infants and young children of the colored race. The disease has many features in common with the congenital blood dyscrasias of the white and other races, namely Mediterranean or Cooley's erythroblastic anemia, splenic anemia, familial hemolytic icterus and fetal hydrops as well as fetal erythroblastosis.

All the cited anemias are usually fatal in childhood due either to progressive episodes of blood destruction (crises) or to intercurrent infections, especially of the respiratory tract. Only some milder cases are known to have survived childhood or have been discovered in adult life.[12,27]

We have had the opportunity of studying the case of a colored male who was found to be affected by sickle cell anemia at the age of forty-three. In view of some unusual roentgenologic and interesting clinical features this case is herewith reported.

CASE REPORT

R. H., aged forty-three, colored male, barber, was admitted to City Hospital (Urological Services of Dr. T. J. Kerwin) on October 3, 1941, with a urethral discharge of three weeks' duration, the condition having developed five days following sexual intercourse. The disease responded well to sulfathiazole therapy and massage of the prostate so that the patient could be discharged from the hospital twenty-six days later.

Of special interest in this case was a stunted growth, underdevelopment and emaciation. The history revealed that the patient had suffered from "rheumatism" all his life with episodes of painful swelling of joints and lassitude since early childhood. There was also a vague history of a familial tendency toward "rheumatism."

Examination revealed a barrel-shaped emphysematous chest and exaggeration of the thoracic and lumbar curves. The right knee was somewhat tender and swollen at the time of admission and during the first week in the hospital. Above the ankles were noted symmetrical superficial leg ulcers which responded well to local therapy. The abdomen was soft, and there was no enlargement of liver and spleen. Temperature varied from 98 to 102.5° F., pulse from 80 to 100 and respiration from 16 to 22.

Physical examination of the chest revealed a systolic murmur at the cardiac apex which suggested mitral heart disease, most likely on a rheumatic basis. Roentgenograms of the chest, however, showed normal heart and lung, the only positive findings being peculiar sclerotic and porotic changes of the ribs. Therefore, the entire skeleton was surveyed with the following findings:

Ribs (Fig. 1): Peculiar osseous texture, areas of porosis being intermingled with coalescent coarse and sclerotic trabeculae. Linear and irregularly shaped zones of decalcification in upper ribs. Marked generalized decalcification of lower ribs. Coarse trabeculation of clavicles and neck of scapulae.

Cervical and Thoracic Spine (Fig. 2): Ballooning of cervical discs with biconcave shape of cervical bodies. Coarse trabeculation of vertebrae. Thinning of thoracic discs and exaggeration of thoracic curve. Flattening, lipping and coarse trabeculation of thoracic bodies with porotic areas posteriorly.

Lumbosacral Spine and Pelvis (Fig. 3 and 4): Lipping and flattening, also sclerotic and porotic areas of vertebral bodies as seen in the thoracic area. Ballooning of discs as found in the cervical region. Exaggeration of the lumbosacral curve. Coarse trabeculation of sacrum, iliac crests, lower parts of pelvis and upper parts of femora. Decalcification of central parts of iliac bones. Mushroom deformity of femoral heads and moderate bilateral coxa vara deformity.

Skull (Fig. 5): Frontal hyperostosis, especially of outer table, with obliteration of diploe.

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Periosteal new bone formation in parietal area containing minute vertical channels anteriorly. Diffuse osteoporosis of lower parts of cranial vault.

Legs and Feet (Fig. 6): Coarse trabeculation and splotchy osteoporosis of tibia and fibula. Irregular periosteal proliferation of right lower fibula (as seen secondary to varicosities and chronic ulcers of the legs). Enlargement of metatarsal heads and shafts with medullary widening and cortical thinning. Atrophy of tufts of distal phalanges of right second and fourth toe.

Femora and humeri showed changes similar to those of tibiae and fibulae.

Bones of forearms, wrists and hands were free from gross changes.

The roentgen findings remained unchanged on follow-up studies in December, 1941, February, 1942 and April, 1942.

Laboratory studies revealed the following findings: Electrocardiogram was normal, likewise the blood pressure (120/80). Wassermann reaction and Kahn test were repeatedly negative. Urethral smears were also negative for gram-negative diplococci. The urine was negative for albumin, sugar and Bence-Jones protein; spe-

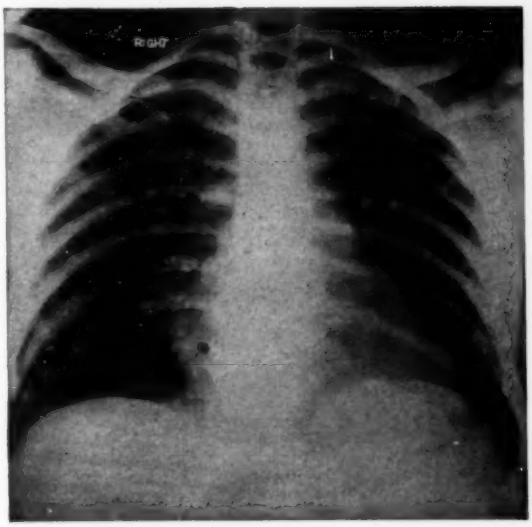

Fig. 1. Coarse trabeculation and osteoporosis of ribs. Marked decalcification of lower ribs. Coarse trabeculation of clavicles and neck of scapulae.

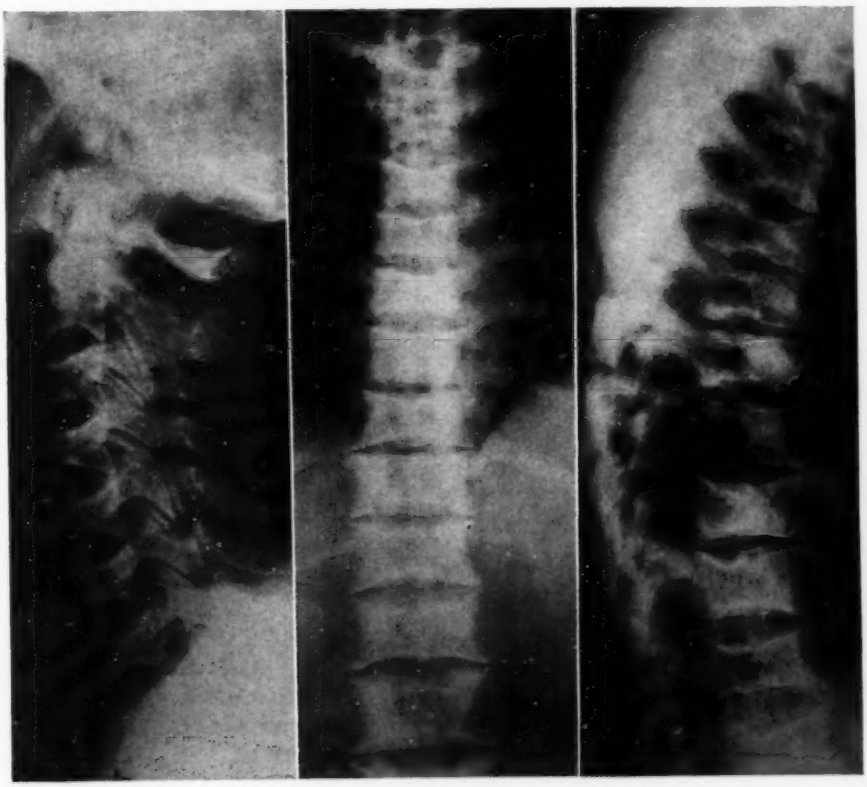

Fig. 2. Ballooning of cervical discs with biconcavity of vertebral bodies. Flattening, lipping and coarse trabeculation of thoracic bodies with porotic areas posteriorly.

cific gravity was 1.011; microscopically only phosphate crystals were found. Non-protein nitrogen values, blood sugar, uric acid, chlorides and phosphorus were normal. Blood calcium was 11.1 mg. per 100 cc. in October, 1941

FIG. 3. Changes in lumbar vertebrae similar to but more pronounced than in cervicodorsal region. Ballooning of discs and biconcavity of vertebral bodies most pronounced in lumbosacral area.

and 12.1 mg. in April, 1942. Alkaline phosphatase was normal in October, 1941 (4.5 Bodansky units) but elevated in December, 1941 (8.7 units) and again normal in April, 1942 (4.6 units). The icterus index was increased, varying from 18 to 36.

Leukocyte count varied from 9,000 to 12,000 per cu. mm. with 58 per cent neutrophiles and 42 per cent lymphocytes. Nucleated red cells were not observed, but there was marked sickling of red cells, best seen in the twenty-four hour preparation. Red cell count varied from 2,600,000 to 4,400,000 per cu. mm. and the hemoglobin from 55 to 80 per cent (Sahli). Bone marrow smears showed marked megaloblastic reaction.

Fragility test revealed increased resistance of red cells to hypotonic solutions of sodium chloride. There was no hemolysis at 0.88 to 0.40 per cent NaCl but partial hemolysis at 0.36 to 0.24 per cent NaCl. Survey of the family with special reference to the Rh factor was not undertaken at that time, and additional studies were not made recently because the patient could no longer be located.

FIG. 4. Coarse trabeculation of sacrum, iliac crest, lower pelvis and upper femora. Decalcification of iliac fossae. Mushroom deformity of femoral heads and bilateral coxa vara deformity.

COMMENT

The reported case is of special interest because of the unusual roentgen findings and the patient's advanced age. Most cases are seen in the first two decades of life, the youngest patient being less than four months old.[31] Nevertheless, some cases have been discovered at an advanced age, the oldest being sixty-two.[27] The average age has been reported as thirteen.[1] Males are more frequently affected than females, the proportion being three to one[1] and two to one,[20] respectively in favor of males. Since the disease has rarely been seen in older people, the roentgen findings of our case are so far still very unusual. The only similar case found by us

in the American literature is that of a colored male, aged fifty-one, reported by Diggs, Pulliam and King.[12]

The advanced roentgen findings suggest a severe degree of anemia. On the other hand, clinical and laboratory findings and the fact that the case has been accidentally discovered in late middle life speak for a relatively mild form. The advanced skeletal changes apparently suggest chronicity but not severity of the disease. This conclusion has been repeatedly made[12] and it has been stated that in severe anemia the skeleton may occasionally remain uninvolved. Therefore, the absence of osseous lesions does not exclude the possibility of true sickle cell anemia, and the differential diagnosis between this anemia and other forms in which the phenomenon of sickling of red cells (sickle cell trait or sicklemia) is incidental cannot be made on the basis of the roentgen findings.

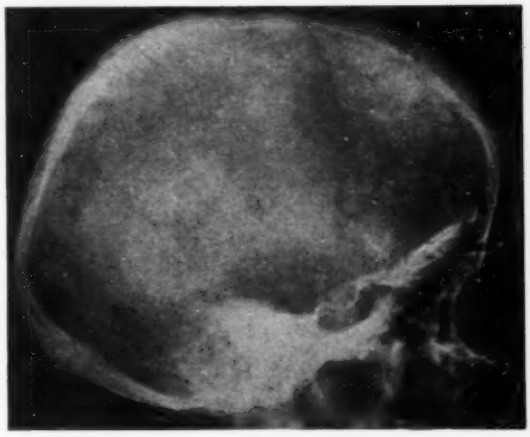

Fig. 5. Frontal hyperostosis. Periosteal new bone formation in parietal area containing minute vertical channels. Diffuse osteoporosis of lower parts of cranial vault.

DISCUSSION

Although sickle cell anemia and other congenital blood dyscrasias are relatively recent discoveries, abundant skeletal findings of ancient Mayan[21] and Peruvian[13] Indians suggest that the diseases may have occurred centuries ago. Etiology and pathogenesis have not been accurately determined, but the following observations point toward an incompatibility of the parents' blood similar to erythroblastic anemia and congenital hemolytic icterus:

Fig. 6. Cortical thickening, coarse trabeculation and irregular osteoporosis in tibia and fibula. Periosteal proliferation of lower fibula. Enlargement of metatarsal heads and shafts with medullary widening and cortical thinning. Atrophy of tufts of distal phalanges of second and fourth toe.

(1) There is a familial tendency with occurrence in several members and generations of the same family.[9,12,18]

(2) The age incidence, course of the

disease and clinical manifestations are very similar to the other congenital blood dyscrasias.

(3) There is very little variation in the hematologic, pathologic and roentgen findings.

Therefore, the phenomenon of sickling may play only a minor or incidental rôle in the etiology and pathogenesis of the disease. Supporting this supposition are the following observations:

(1) Sickle cell anemia is a rare disease, occurring in only 1 out of 40 sickle cell carriers, while sickle cell trait is found in about 7 per cent of the Negro population.[12]

(2) So-called sickle cell anemia is not confined strictly to Negroes but has also been reported in Arabs, Cubans, Italians,[7,14,16] Greeks[8] and Mexicans.[30]

(3) Absence of sickle cells has been observed in a colored family affected by erythroblastic anemia.[10]

The Rh factor, which now plays such an important rôle in erythroblastic anemia, has not yet been determined in the survey of families with sickle cell anemia according to recent literature. Therefore, the question of pathogenesis remains undecided. So far, sickle cell anemia like target cell anemia is still considered an entity, being slightly different from the other congenital blood dyscrasias.

Pathologic studies have been confined to the spleen, liver and bones. The spleen is grossly enlarged in infancy and early childhood, but later it becomes smaller. In the early phase the malpighian bodies are decreased in size, fibrotic and void of germinal centers. The sinuses are dilated and distended with red cells. The pulp is invaded by red cells and is either swollen or atrophic. In older cases there is thrombosis of splenic veins and presence of infarcts. Finally, atrophic changes become predominant with extensive scars, resulting from infarcts, and with calcium and iron incrustration.[2]

The liver shows albuminous and fatty degeneration, the sinusoids being dilated and distended with red cells. There is much hemosiderin in the cells lining the sinusoids and phagocytosis of sickle cells by the Kupffer cells.

The bones show hyperplasia of the marrow with presence of many nucleated red cells, sickle cells and megaloblasts. Diggs, Pulliam and King[12] state that the hyperplastic marrow tends to increase the volume of bone at the expense of the cortex and the sclerosing factors tend to replace the marrow and to substitute in its place osteoid tissue or new bone. Thus two factors appear to be working in opposite directions.

The clinical syndrome is characterized by weakness, easy fatigue, shortness of breath and run-down condition. Most typical are the so-called crises with nausea, vomiting, acute joint pain, fever and leukocytosis. This clinical picture may simulate an acute abdominal condition like appendicitis and cholecystitis.[28] A history of similar previous attacks, however, is usually available. The older patients have been more or less sick since early childhood and give a history of severe childhood diseases, frequent colds, acute rheumatic fever, obscure anemia, tuberculosis or pneumonia.[9] The disease is often discovered while the patient is treated for a respiratory infection.

On physical examination the patients show a stunted growth, emaciation and anemia of oral mucosa and of conjunctivae. The sclerae are yellowish green (83 per cent), tonsils and lymph glands are enlarged especially in the neck and axilla (56 per cent), extremity joints are swollen and painful (54 per cent), the heart is enlarged (54 per cent), and there is a soft systolic murmur at the cardiac apex (72 per cent). Spleen and liver are usually enlarged below the age of four but rarely above the age of seven, the average occurrence being 59 per cent.[1] Abdominal pain occurs in 55 per cent of cases during the crises. Occasionally, the sex development is retarded. Chronic ulcers of the legs with a punched out appearance, resembling syphilitic lesions, are almost constant find-

ings above the age of sixteen years.

The red cell count is diminished anywhere from 3 million to below 1 million and the hemoglobin from 60 per cent to 30 per cent, in severe cases even down to 10 per cent. The color index is fairly normal. There is moderate leukocytosis, occasionally with increase in neutrophiles. During intercurrent infections the white cell count may go up to 30,000 and even 50,000 cells per cu. mm. The blood smear shows anisocytosis, poikilocytosis, polychromatophilia and sickling of red cells. The sickle cells, however, are best seen in the twenty-four hour preparation. There are occasional nucleated red cells, megaloblasts, eosinophiles and myelocytes, also punctate basophilic cells. The red cells show increased resistance to the hemolytic action of hypotonic solutions of sodium chloride. The van den Bergh test is occasionally positive in the direct phase and almost always positive in the indirect phase. The icterus index is increased, likewise phosphatase and blood calcium in the active stage of the disease. The urine shows a low specific gravity and occasionally albumin. Coagulation and bleeding time are usually normal.

Therapy has been ineffective so far. Splenectomy and blood transfusion have given temporary relief in infancy and childhood.[11] In view of marked atrophic changes of the spleen later on, splenectomy is contraindicated in adult life.[2,6] Rest in bed and supportive measures are necessary. Liver extract medication has proved unsatisfactory. Leg ulcers usually respond promptly to local therapy.

The prognosis is very poor in the severe cases of infancy and early childhood. In the milder cases, where patients live beyond the second decade, decreased resistance to intercurrent infections usually proves fatal, and very rarely do patients live beyond the age of thirty.

ROENTGEN DIAGNOSIS

The roentgen findings in childhood have frequently been described,[4,8,12,15,19,24,29] but very little seems to be known about changes in adult life as illustrated in our case.

The skull is the site of most frequent changes with thickening of the outer table and obliteration of the diploic spaces. Fine vertical striations with a "hair-on-end" appearance are seen within and beyond the outer table after the fifth year of life. These perpendicular ray formations in a mild form, however, are not entirely characteristic of blood dyscrasias as they have been observed in apparently normal children with or without rachitis and scurvy.[26] Later in life, the striae are no longer seen, and lamellated periosteal new bone formations are found instead (Fig. 5). The parietal bones are more frequently involved than the frontals. In the lower parts of the cranial vault there is porosis and presence of fine granular structures.

The following bones of the trunk may also be involved: sternum, clavicles, scapulae and ribs (Fig. 1),vertebrae and pelvis (Fig. 2, 3 and 4) and long bones (Fig. 6). In childhood there is usually medullary widening and cortical thinning of tubular bones with possible regression following a crisis.[11] Later in life, there is thickening of cortical bone and sclerosis of cancellous bone, coarsened trabeculae being intermingled with splotchy osteoporotic areas.

The roentgen changes in childhood are quite characteristic but indistinguishable from those of erythroblastic anemia and other congenital blood dyscrasias.[15] In sickle cell anemia, however, the parietal bones usually show more involvement than the frontals, while the reverse is true in the other congenital anemias. Extremity bones, especially of the hands and feet, are less frequently involved in sickle cell anemia.

Later in life the bone changes are quite different due to predominance of sclerotic reactions, as in our case, and must be distinguished from osteoplastic metastatic lesions, osteitis deformans, polyostotic fibrous dysplasia,[23] atypical hyperparathyroidism, marble bone disease, fluorine

intoxication,[3] and from sclerotic bone reactions in aplastic anemia and leukemic conditions.[25] Similar changes have been observed in apparently healthy parents of erythroblastic anemia patients.[5,22]

SUMMARY

A case of sickle cell anemia with unusual roentgen findings, accidentally discovered at the age of forty-three, has been described.

The clinical and pathological features of sickle cell anemia have been discussed and their close similarity to erythroblastic anemia and other congenital blood dyscrasias has been stressed.

The skeletal changes at advanced age are different from those seen in early life and, due to predominance of sclerotic bone reactions, may resemble osteoplastic carcinomatosis, Paget's disease, osteosclerotic anemia and leukemia and bone conditions observed in apparently healthy parents whose children are affected by erythroblastic anemia.

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ANTERIOR VERTEBRAL WEDGING—FREQUENCY AND SIGNIFICANCE*†

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THE presence of one or several wedged vertebrae in roentgenograms of the spine is almost always considered abnormal and etiologically significant. Often, with this finding alone, the diagnosis of an old compression fracture is made. Because of the important consequences of such a diagnosis, it behooves roentgenologists to determine the normal variations of vertebral wedging.

The purpose of the present study is to evaluate the significance of plain, uncomplicated, anterior wedging in otherwise normal vertebrae. This can only be done by the determination of the frequency distribution of wedging of normal vertebrae and its analysis.

This study is based upon a group of 575 World War II veterans, all males, seen in the Department of Radiology of the Pittsburgh Veterans Administration Regional Office. Of the entire group 519 had complaints of backache or had roentgenograms of the back to determine the presence of a foreign body. Fifty-six lateral roentgenograms of the chest with sufficiently clear bony detail were used; in this group there were no complaints referable to the back. Those veterans complaining of backache had been discharged from the armed services for this disability. Their service records with all the clinical, laboratory and roentgen reports were available to us and were extensively used in this study. Most of our patients were young adult males, as seen in the following table:

Years	Under 20	21–30	31–40	41–50
Percentage	1.9	48.9	37.9	11.5

All pathological vertebrae were eliminated from the group, not only the obvious compression fractures and residual deformities of epiphysitis, but also those in which a case history of a serious back injury was elicited and a previous diagnosis of compression fracture had been made. Any anterior wedging was considered pathological if due either to a slant of the upper surface or associated with other deformities, such as lateral wedging, spreading of the body of the vertebrae, flattening and projection of the anterior margins, involvement of the adjacent discs, localized osteoarthritis, waviness of the upper and lower surfaces or step-like notching of the anterior margins. It is likely that, despite these restrictions, a few residual deformities due to compression fractures are included, but in view of the large number of vertebrae measured, this cannot modify either the averages or standard deviations. As seen from the age distribution, we are not dealing with the older age group in which demineralization has produced anterior wedging.

It is generally accepted that the heights of the anterior aspect of the vertebrae increase caudally. This is often used as a way to determine whether the vertebra is normal. If, for instance, the anterior aspect of L_3 is less than that of L_2, it is assumed that L_3 has been anteriorly compressed. Many spines do not obey that rule as both the anterior and posterior aspects may be smaller, with no appreciable wedging (see Fig. 1). Conversely, there may be a slight increase of the anterior aspects of the vertebrae and, nevertheless, there may be wedging. Even if this rule helps to determine the presence of wedging, it is still necessary to evaluate its significance.

* From the Veterans Administration Regional Office, Pittsburgh, Pa.
† Published by permission of the Veterans Administration. This paper does not reflect any policy of the Medical Director or the Veterans Administration, and neither the Medical Director nor the Veterans Administration assumes any responsibility for statements contained in the paper.

STATISTICAL METHOD AND ANALYSIS

Vertebral wedging must be represented by figures. Visual impressions are not reliable because variation in the curves of the spine and shapes of the vertebrae may produce optical illusions, both as to the presence and as to the amount of wedging. For instance, a vertebra may have the shape of a parallelogram instead of a rectangle and look wedged when actually it is not.

We measured from lateral roentgenograms of the dorsal and lumbar spine the heights of anterior and posterior aspects of 3,836 vertebrae (see Fig. 1). The outlines

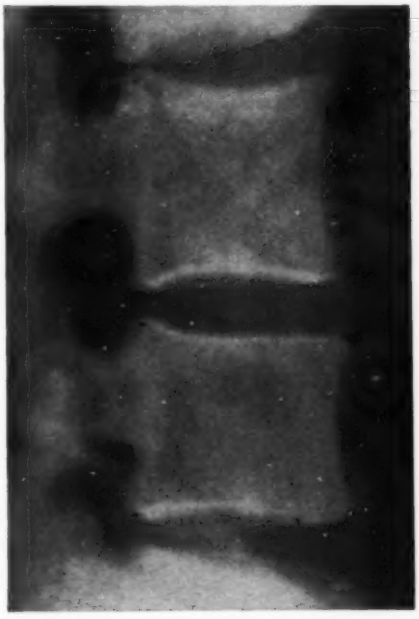

Fig. 1. S.Y. This figure illustrates that a normal vertebra may have an anterior aspect smaller than that of the vertebra above. In this instance, measurements of the anterior and posterior aspects of L3 and L4 are 4 and 4.1 respectively. The measurements of L4 are 3.45 and 3.7 cm., giving an index of wedging 1.07 cm., which is normal.

of the bodies of these vertebrae were necessarily distinct, otherwise accurate measurement could not have been made. If a vertebra was not on the central ray of the beam, the four posterior corners had to be identified, the two posterior borders measured, and the mean taken (see Fig. 2). The

Fig. 2. R. B., aged thirty-four, received an ill defined injury to his spine. The index of wedging of L1, which is obviously wedged, is 1.22 cm. This was interpreted in the service as a compression fracture. From Table III one sees there is an occurrence of 10 per cent. In view of this percentage and an ill defined injury, a compression fracture is unlikely.

measurements were then used to calculate the following ratio:

$$\frac{\text{Height of the posterior aspect}}{\text{Height of the anterior aspect}} = \text{Index of wedging, or (Iw)}$$

This ratio is greater than one when the wedging is anterior, and less than one when the wedging is posterior. For each vertebra, from D_4 through L_5, the mean index of wedging and the standard deviation (s.d.) were calculated. Table I gives the result. It can be seen that the average wedging of the vertebrae is close to one in the lower lumbar region and is less than one in L_5. The evaluation of the amount of wedging present depends upon the level. For instance, an Iw of 1.05 for L_5 or 1.15 for L_4 is far from the mean; whereas such an index of wedging would be below or very close to the mean at higher levels. Therefore, a greater amount of wedging within

Fig. 3. M. G., aged thirty-six, received an injury to the neck in the past but has no history of direct back injury. There is slight wedging of L_4, an index of wedging of 1.16, which was diagnosed in the service as compression fracture. This index of wedging, at higher levels of the spine, would be normal but at the level of L_4 its occurrence is less than 5 per cent. It is probable that this vertebra is abnormal but, due to the absence of a direct back injury, this wedging is more likely the residual deformity of epiphysitis.

normal limits is allowed in the dorsal and upper lumbar than in the lower lumbar spine (see Fig. 3).

The significance of the standard deviation can be easily illustrated by Table II. In Column A are noted the means plus one standard deviation; in Columns B and C are the actual numbers and percentages of these vertebrae with an index of wedging above or equal to these values. They represent 17 per cent of the total. It must be emphasized that these vertebrae are all visibly wedged and might be interpreted as pathological.

The tabulations of numbers and percentages for vertebrae with indexes of wedging above or equal to the means plus twice the standard deviation are in Columns E and F. These vertebrae are strikingly wedged, and they represent 5 per cent of the total. There is no absolute evidence that some of the high indexes of wedging are not the consequences of old compression fractures, but, on a probability basis, it is extremely likely that this event is limited and in a large group it can be disregarded.

One can see that the scatter varies slightly from one vertebra to another. For

Table I

Means, Ranges and Standard Deviations of the Indexes of Wedging

Vertebrae	A	B	C	D	E
	No.	Mean Index of Wedging	Range Min.	Range Max.	Standard Deviation
D_4	82	1.07	1.00	1.25	0.060
D_5	138	1.08	1.00	1.28	0.065
D_6	176	1.10	1.00	1.32	0.065
D_7	201	1.13	1.00	1.42	0.075
D_8	222	1.13	1.00	1.40	0.070
D_9	234	1.10	0.93	1.35	0.080
D_{10}	286	1.08	0.97	1.37	0.070
D_{11}	339	1.12	1.00	1.40	0.080
D_{12}	335	1.12	1.00	1.39	0.070
L_1	337	1.11	1.00	1.45	0.075
L_2	364	1.06	0.97	1.37	0.070
L_3	383	1.04	0.91	1.32	0.060
L_4	387	1.01	0.89	1.38	0.060
L_5	347	0.91	0.75	1.21	0.070
Total:	3,836				

TABLE II

ANALYSIS OF THE SCATTER OF THE INDEXES OF WEDGING

Vertebrae	A	B	C	D	E	F
	Mean +1 Standard Deviation	No.	Per Cent	Mean +2 Standard Deviations	No.	Per Cent
D_4	1.130	14	17.0	1.190	3	3.6
D_5	1.135	29	21.0	1.210	7	5.0
D6	1.170	33	18.7	1.235	9	5.1
D_7	1.205	33	16.4	1.280	10	4.9
D8	1.200	43	19.4	1.270	10	4.5
D_9	1.180	39	16.6	1.260	9	3.9
D_{10}	1.150	55	19.2	1.220	13	4.5
D_{11}	1.200	57	16.8	1.280	27	7.9
D_{12}	1.190	57	17.0	1.260	23	6.9
L_1	1.185	52	15.4	1.260	17	5.0
L_2	1.130	55	15.1	1.200	16	4.4
L_3	1.100	65	16.9	1.160	14	3.7
L_4	1.075	57	14.8	1.135	18	4.6
L_5	0.980	67	19.3	1.050	12	3.4
Total:		656	17		188	5
Percentage:						

Average percentage Column C—17 per cent.
Average percentage Column F—5 per cent.

the sake of homogeneity, the indexes of wedging were tabulated in Table III according to the percentages of occurrence. Fifteen per cent of the vertebrae have an index of wedging above or equal to the figures of Column A; 10 per cent of Column B; and 5 per cent of Column C. This last percentage is low enough to justify considering Column C as the upper limit of normal. A vertebra with an index of wedging above these limits is not necessarily abnormal, but because of its rarity, it may be on a probability basis, considered as such. If an index of wedging is below the value in Column A, it is commonly found and cannot be considered abnormal. To determine the significance of a wedged vertebra, one may refer to Table III and readily determine the percentage of normal vertebrae with the same index of wedging.

It is interesting to note that the number of outlying indexes of wedging is a function of the wedging strain of the various levels of the spine. It has its maximum at the level of D_{11} and D_{12} and its minimum in the upper dorsal and lower lumbar region. This corresponds with the high incidence of compression fractures of D_{11} and D_{12}.

It was thought worth while to find out if there was any difference between the

TABLE III

INDEXES OF WEDGING BY PERCENTAGE OF OCCURRENCE

Vertebrae	A	B	C
	15%	10%	5%
D_4	1.13	1.16	1.19
D_5	1.15	1.17	1.21
D6	1.18	1.20	1.24
D_7	1.21	1.24	1.28
D8	1.22	1.23	1.27
D_9	1.20	1.21	1.26
D_{10}	1.16	1.19	1.21
D_{11}	1.21	1.24	1.31
D_{12}	1.20	1.24	1.27
L_1	1.19	1.21	1.26
L_2	1.13	1.16	1.19
L_3	1.11	1.13	1.15
L_4	1.08	1.10	1.13
L_5	1.00	1.01	1.03

frequency distribution of wedging in the non-backache (those taken from the lateral roentgenograms of the chest) and the backache group. In all, there were 1,684 vertebrae from D_4 to D11; 1,326 from the backache group and 358 from the non-backache group. In the former group, 17 percent have an index of wedging above or equal to the mean plus once the standard deviation as compared with 16 per cent in the latter group. Eleven vertebrae of the lateral chest group have an index of wedging equivalent to the mean plus twice the standard deviation. The lateral chest group is too small for a statistically valid comparison of the far outlying values. It can only be pointed out that in this group, where there is no complaint referable to the back, strikingly wedged vertebrae are found (see Table IV). The comparison of the distribution of the index of wedging between the backache and the non-backache group seems to indicate that there is no correlation between wedging and backache.

TABLE IV

LATERAL CHEST GROUP

Vertebrae	Index of Wedging ≧mean +1 s.d.	Index of Wedging ≧mean +2 s.d.
D_4	5	0
D_5	3	1
D6	7	2
D7	7	0
D8	8	1
D9	10	2
D10	8	1
D11	9	4
Total:	57	11

DISCUSSION

Uncomplicated wedging, i.e. symmetrical wedging without the association of other deformities, within the limits determined in Table III, is of rather common occurrence and consequently has no clinical significance. With this finding alone one cannot make the diagnosis of a former fracture despite the history of a back injury (Fig. 2). A slight wedging may be the only residual deformity of a compression fracture but there is no way of ascertaining it without former roentgen evidence of a fresh fracture (Fig. 4). We are forced to this conclusion by the above statistical study demonstrating the normal variation of vertebral wedging.

FIG. 4. D. P., aged twenty-eight, received a back injury in a fall three years previously. D11 has an index of wedging of 1.26 (occurrence 10 per cent), and D12 has an index of wedging of 1.16 (occurrence 15 per cent). On the upper surface of D11 there is a large Schmorl's node. D12 has a minimal deformity of the upper anterior corner and a slight waviness of the lower surface. This would be considered normal or minimal residuals of an epiphysitis. A lateral roentgenogram of the spine, taken immediately after his back injury, shows a fresh compression fracture of D11 and a chip fracture of the upper anterior corner of D12.

The problem is identical in considering tumors or infections. The presence of wedging, without sclerosis or bone destruction, cannot be interpreted as a sign of pathological fracture. Even if there is local tenderness and other clinical evidence of disease, the wedging adds only slight support to the clinical diagnosis.

For compensation purposes in an individual case, some conclusion as to whether a wedged vertebra is pathological must be reached. The severity of the injury, its type, (i.e. if likely to produce a compression fracture) and the number of vertebrae involved must be weighed against the percentage of occurrence of the indexes

Fig. 5. H. B., aged twenty-six, was thrown against a tree in a bomb concussion. There is symmetrical wedging of L4 (Iw = 1.40) with a slight deformity of the right upper corner. The high index of wedging along with the type of injury makes the diagnosis of fracture very probable.

of wedging expressed in Table III (Fig. 2 and 5). The conclusion so reached is based on probability but many conclusions in other medical problems are reached in the same way and widely used. Tables for blood pressure and size of the heart, giving predicted values and upper limits of normal, use the same statistical method.

In any study concerning the plain, uncomplicated, vertebral wedging, one must discuss its relationship to epiphysitis, an even more common cause of wedging than compression fractures. In our group of 550 adult male veterans under fifty years of age, in spite of the increased hazard of back

Fig. 6. T. M. A., aged twenty-six, received a back injury twelve years previously while playing football. For many years since that time he has had back pain. There is wedging of D11 and D12 with indexes of wedging of 1.52 and 1.45 respectively. The lower surfaces of D11 and D12 are slightly scalloped. There is also some slight waviness of the upper surfaces of D8, D9 and D10. The various roentgenological diagnoses in the service and civilian life have been about half in favor of epiphysitis and half in favor of a compression fracture. This points out the impossibility, at times, of reaching a positive conclusion.

injury during military life, there were 17 proved cases of compression fracture to 33 cases of juvenile epiphysitis. The latter cases included only those satisfying rigid criteria. Doubtful cases were numerous.

Epiphysitis may involve one, two or several vertebrae. The greater the extent,

Fig. 7. Y. V., aged twenty-five, had a definite kyphosis at induction. In Tunisia he was thrown from a truck. The diagnosis of a compression fracture was made but we have no report of the roentgenograms taken immediately after the injury. The report of films taken three months later describe wedging of D9 as we now see it. D9 has an index of wedging of 1.55. The anteroposterior view is negative. The presence of a kyphosis at induction and the absence of other deformities, despite the marked wedging, are in favor of an old epiphysitis rather than a compression fracture.

the easier is the diagnosis. Even if only one or two vertebrae are involved, the diagnosis is fairly certain if one finds smooth, wavy indentations on the upper and lower surfaces of the bodies and step-like, smoothly curved notchings on the anterior margins. The residual deformities of juvenile epiphysitis show a slow gradation from a pathognomonic roentgen appearance to a plain, symmetrical wedging. Nathan and Kuhns[2] have reported cases in which the umbilications and notching, present in the active phase, disappeared in later life, leaving an uncomplicated symmetrical wedging. Epiphysitis can be reasonably ruled out as the cause of wedging if the slant of the upper surface is distinctly greater than the lower or if there is any definite depression of the upper surface. When there is no typical associated deformity, the problem is insoluble because then there is no way to differentiate traumatic wedging from epiphysitis (Fig. 6 and 7). It is likely that epiphysitis is a more common cause but in any individual case only a probable conclusion can be reached. It might even be postulated that variations in the softening of the epiphyseal plates, under the great mechanical strain which the vertebrae must stand, might be the possible explanation of the rather wide variation of vertebral wedging. In rare instances healed demineralization may leave wedging as the only residual deformity.

SUMMARY

All anatomical and physiological figures have a frequency distribution, and vertebral wedging does not escape this universal statistical law of nature. The variations around an average must be taken into consideration in any delimitation between the normal and the abnormal. A theoretical explanation of the rather wide divergence is discussed. The probability of normal occurrence of the outlying values of vertebral wedging is given in Table III. Epiphysitis is probably a more common cause of plain wedging than compression fracture.

CONCLUSION

Plain, symmetrical, uncomplicated wedging of the vertebrae, within the limits determined in Table III, is a normal occurrence. When close to or beyond these limits the cause cannot be determined with certainty.

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SOLITARY MYELOMA OF BONE*

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PRIMARY lesions involving the ischium are comparatively uncommon. When the lesion proves to be a solitary myeloma the occurrence is of even greater rarity. A review of the literature testifies to the rarity of such occurrence. Up to October, 1945, a total of 61 cases of solitary myeloma of bone have been recorded. Of these, 14 cases involved the pelvis and in none of these did the lesion begin primarily in the ischium.

Geschickter[5] in 1930, and Cutler, Buschke and Cantril[3] in 1936 were apparently among the first investigators to call significant attention to this interesting subject. In an enlightening report, the latter reviewed the topic of single myeloma of bone and presented 18 cases up to that time, including 1 case of their own.

In 1940 Paul and Pohle[9] further added to the knowledge of the subject, and brought the literature up to date in a comprehensive and crystallizing review of the roentgenologic features of 45 cases of solitary or single focus type of myeloma. These represented 40 examples from the literature and 5 of the authors' cases.

Subsequently, and more recently, Willis,[15] Abel,[1] Tilden,[12] Toth and Wintermantel,[13] Batts,[2] and Schwartz[11] have contributed additional cases. Gootnick,[6] in the latest paper on solitary myeloma (October, 1945), brought the total number of cases thus far recorded to 61 by reporting 2 of his own in an excellent review of the previously recorded 59 in the literature. Among these the most frequent location of the tumors was found to be in the pelvis (14 cases), dorsal spine (9), femur (9), humerus (9) and skull (5). In the pelvis the ilium was the bone most frequently involved (13). Not one case was reported in which the ischium was the primary and only bone involved.

Because of the rarity of solitary myeloma of bone in general, and because the case herewith presented is the only one thus far observed occurring in the ischium alone, it is reported in some detail.

REPORT OF CASE

A.D.C. (No. 55065), white male, aged fifty, was admitted on May 21, 1943, with a history of having developed sciatic-like pain in the right hip radiating down the right leg in September, 1942. Because the pain persisted he reported to a local doctor in December, 1942, and roentgenograms were made. A letter received from the doctor stated that these revealed an osteolytic, destructive lesion of the right ischium. Because it was extensive and not limited by cortex, it was thought to be a malignant neoplasm, probably an osteogenic sarcoma and roentgen therapy was instituted. No biopsy had been attempted. In the letter the following data were given concerning the therapy. Between December 12, 1942 and January 1, 1943, three treatments per week were given, alternating between an anterior and posterior right pelvic field, measuring 15 by 15 cm., each receiving 1,060 r (in air) with 200 kv., half-value layer equivalent to 1.1 mm. copper. Using the identical factors and same intervals, and the same two fields, between January 30, 1943 and February 20, 1943, 1,325 r (in air) was delivered to each field. And finally, between March 13, 1943 and March 26, 1943, again using all the same factors, an additional 1,060 r (in air) was given to each of the same two fields. On May 1, 1943, the doctor furthermore stated: "A roentgenogram revealed slightly greater bone destruction in the right ischium." Because of this the patient was referred to our hospital for further treatment. At the time of admission he complained of mild pain in the region of the right inferior buttock only when stepping hard on his right foot or toes, or when bearing all his weight on the right foot. He had not lost any weight, and he had no other complaints. He never had pain in any other bones.

Physical Examination. This revealed a white male who was well developed and nourished and not at all ill-looking. He walked with a gait

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slightly favoring the right leg, although actually it could not be called a limp. The general examination, including heart, lungs and abdomen, was devoid of positive findings. There was no clinical sign of neoplasm in the oral cavity, nasopharynx, thyroid, breasts, kidneys or testes. Rectal digital examination revealed no shelf or tumor and the prostate was normal in size, shape and consistency. Locally there was no asymmetry of the buttocks. There was slight tenderness on deeper palpation over the right

FIG. 1. Multicystic, osteolytic lesion in right ischium with slight expansion of upper half of bone. There is destruction of cortex on the inferior border below acetabular margin. Soft tissue tumefaction is noted external to this. No proliferative bony changes are present.

sciatic notch and ischial tuberosity. There was no evidence of muscle spasm, and Lasègue's sign, the abduction and straight leg raising tests were all negative. There was absolutely no limitation of motion at the hip joints. Neurological tests were all within normal limits and no abnormal deep reflexes were encountered in both lower extremities.

Laboratory Data. The blood Wassermann and Kahn tests were both negative. On four occasions (May 31, June 25, 28 and 29, 1943), the examination of the urine gave negative results for Bence-Jones protein. These and several other urine specimens were also found to be normal for all the other constituents. The admission blood count showed a hemoglobin of 16.5 grams per 100 cc. of blood and a leukocyte total of 7,800. A later blood count, preoperatively, showed hemoglobin of 12.3 grams per 100 cc. of blood, with 3,690,000 erythrocytes, 6,900 leukocytes with a differential count of 64 per cent polymorphonuclears, 34 per cent lymphocytes and 2 per cent monocytes. On May 24, 1943, blood chemistry examination returned the following results: urea nitrogen 13.6 mg. per 100 cc. of blood, sugar 93 mg., calcium 10.6 mg., inorganic phosphorus 3.6 mg., acid serum phosphatase 1.8 units (normal up to 4 units), and alkaline serum phosphatase 13.2 units (normal up to 12). A repetition of the blood studies on July 5, 1943, revealed the calcium to be 9.4 mg. per 100 cc., the acid phosphatase 2.3 units, alkaline phosphatase 7.4 units, serum albumin 3.9 and serum globulin 3.1 grams per 100 cc.

Roentgen Examination. On May 24, 1943, roentgenograms of the heart and lungs disclosed no abnormalities. The thoracic cage also revealed no pathological condition. In the bony pelvis, however, there was observed a destructive, osteolytic lesion involving practically the entire right ischium. The area of osteolysis was more prominent in the upper half of the ischium and there seemed to be slight expansion of the bone in this area. The osteolysis approached the ischial border of the acetabulum but did not cross this to involve the joint space. The inferior border of the upper half of the ischium revealed in addition, a defect, due to an area of dissolution of the cortex 1½ inches in diameter. Throughout the rest of the ischium could still be seen areas of thinned out bone through which trabeculation of bone was still present (Fig. 1). The rest of the pelvis, including the upper one-third of both femora, was normal in appearance.

Preliminary roentgenogram of the abdomen (June 7, 1943) showed the kidneys to be normal in size, shape and position. The psoas shadows were clearly defined. Intravenous pyelograms revealed no abnormalities and kidney function was apparently good. On June 26, 1943, roentgenograms of the skull, both humeri, both femora and dorsal spine were all within normal limits. The lesion in the right ischium, however, showed further destruction and just below the acetabular border the appearance almost resembled a pathological fracture in nature (Fig. 2*A*).

Operative Findings. Under spinocaine anesthesia (June 8, 1943), a biposy of the right ischium was attempted by inserting a bone drill aspirating needle through a tiny skin incision. The sliver of tissue removed showed no evidence of tumor. On June 14, 1943, under spinal anesthesia an incision was made in the right buttock overlying the ischial prominence

and carried down through the muscles. The periosteum was elevated from the ischium. An osteolytic process was encountered within the bone. Several pieces of tissue removed were described by Dr. D. K. Pinks, the surgeon, as mottled-gray and reddish-brown in color and felt gritty.

Due to the large amount of bleeding within the bone, a large quantity of bone wax was used to pack the cavity and control bleeding. Twelve days postoperatively and two days after removal of the sutures, and even though the wound was healing satisfactorily, the patient reached over his bed to obtain something from his bedtable and strained himself. The wound over the right buttock opened and bled a good deal and had to be packed with gauze. From this time until the hemipelvectomy this area continued to drain a small amount of dark blood and debris containing bone wax.

In view of the pathological diagnosis of plasma cell myeloma from the tissue removed above (see microscopical description), and in view of the further facts that the lesion was a solitary one and had become progressively worse in spite of irradiation, and would not doubt soon involve the hip joint, and also because no other primary source could be found to account for the pathology, it was felt that the only chance of cure left for this patient was for immediate radical surgery. A right hemipelvectomy was therefore recommended.

On July 15, 1943, under nupercaine spinal anesthesia and 500 cc. of citrated blood and intravenous fluids, a right hemipelvectomy was accomplished by Dr. R. B. Moreland. The operation lasted two and one-half hours. The postoperative condition of the patient was good. At one stage of the operation, although an attempt was made to sever the attachments to the pelvis in the vicinity of the tuberosity as far away from the ischium as possible, the draining sinus tract was opened in completing the amputation. For this reason the entire sinus tract from the skin through the deeper tissues was excised. This defect through the buttock was only partly closed with interrupted cotton sutures, leaving an opening through which a large Penrose drain was inserted for drainage.

The patient was placed on sulfadiazine therapy postoperatively. On the second day profuse serosanguineous drainage from the operative area was noted, and the temperature rose to 102° F. On the third day the profuse drainage was still present and the patient's general condition was poor. Supportive treatment in the form of intravenous fluids, caffeine and 500 cc. of whole blood was continued. The patient developed a chill at the end of the transfusion. The temperature following this was irregular and as high as 103° F. He was also placed in an oxygen tent. The next day (fourth

Fig. 2. *A*, one month later. Further destruction and osteolysis of right ischium, with pathological fracture. *B*, normal left ischium for comparison.

postoperative) the entire operative area was laid wide open and irrigated with peroxide, and subsequently, continuous packs of 5 per cent sulfathiazole solution were used. Smears from the wound after it was laid open disclosed gram-positive diplococci, gram-negative bacilli and a rare gram-positive bacillus. The cultures revealed *B. aerogenes*, *B. pyocyaneus*, *B. subtilis* and *Streptococcus haemolyticus*.

In spite of all this the patient died at 6:50 A.M. on July 20, 1943, five days after the hemipelvectomy.

Pathology and Histology. The tissue removed by incisional biopsy (June 14, 1943), on microsection revealed large masses of plasma cells, fairly large in size and round and oval in shape. The nuclei were eccentric and the cytoplasm

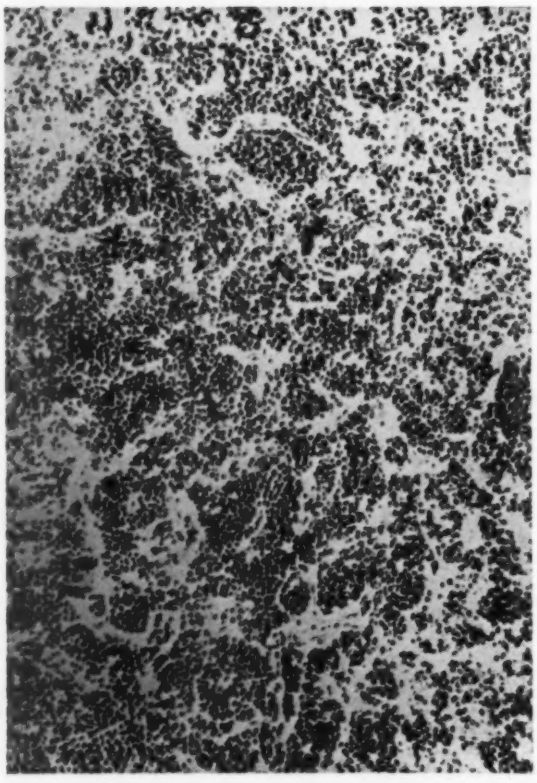

FIG. 3. Photomicrograph (×100). Shows highly cellular nature of the tumor. Large collections of plasma cells are seen with scanty stroma.

was light blue and granular. The nuclei contained one to two nucleoli and the chromatin was arranged in a spoke-like fashion. After hemipelvectomy (July 15, 1943) the resected specimen consisted of the entire right leg and right half of the pelvis. The superior aspect of the superior ramus of the ischium was necrotic throughout its entire extent. This entire area was surrounded by fibrotic tissue except at its posterior aspect where there was an aperture measuring 1.5 by 2.5 cm. The necrotic area contained grayish-yellow rounded tissue masses averaging 0.8 cm. in diameter. They could be easily crushed and disclosed no evidence of calcification. The necrotic process extended up to the inferior aspect of the acetabulum but there was no sign of invasion of the joint space.

Microsections of the tissue removed from the ischium proper and the inferior acetabular region revealed large collections of plasma cells, the individual cells themselves being rather large and round and oval in shape. They were packed closely together and the stroma was scanty. The nuclei were placed eccentrically and mitoses were not seen. The cytoplasm was light blue and granular. Bony spicules were present which were undergoing necrotic changes and were surrounded in part by dense fibrotic tissue (Fig. 3 and 4).

The specimen of tissue removed which contained the draining sinus measured 11.5 by 6.5 by 5 cm. and sections through several areas of this showed a large amount of fibrotic tissue infiltrated with inflammatory cells, surrounding striated muscle which was undergoing degenerative changes. Foreign body giant cells were present throughout the section.

DISCUSSION

Because of the rarity of the case reported, the subject of solitary myeloma of bone in general merits some discussion. These tumors usually occur in the fifth decade of life, are more common in males,

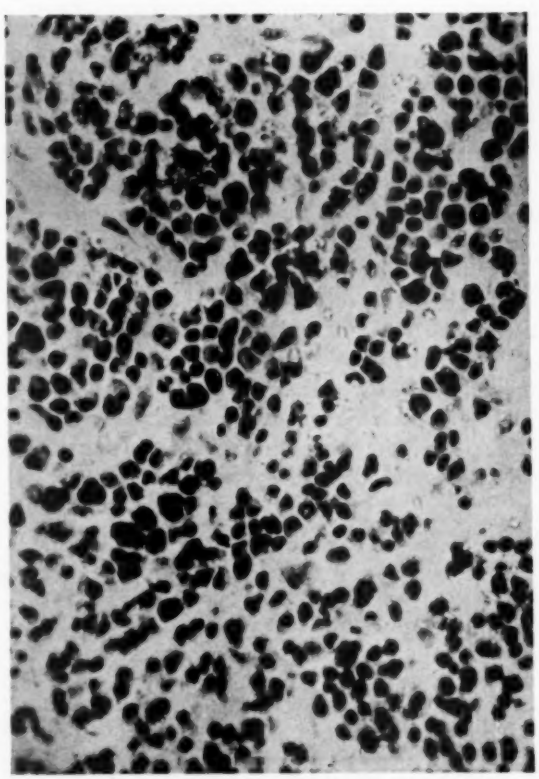

FIG. 4. Photomicrograph (×430). Individual plasma cells with dark staining and eccentrically placed nuclei are seen in greater detail. The chromatin of many of the latter is arranged in spoke-like fashion. Mitoses are not seen.

and are located most frequently in the pelvis, spine, femur, humerus and skull. As Paul and Pohle[9] emphasize, there are certain features in most of the cases recorded which place this group apart from the usual and more common multiple myeloma. In fact, Cutler,[3] *et al.* further separate the solitary form of myeloma into two clinical types. Those that are solitary at first and later become multiple or generalized; and second, the rare and true type which remains localized and solitary for a long period, four to twelve years (proved cases), and possibly twenty years in Willis' case.[15] In those patients in whom the disease became generalized,[9] the time from the first observation to the onset of the generalization varied from two months to three years. The longest recorded observation was reported by Vihvelin.[14] This patient was alive, although showing recurrence in the dorsal vertebrae, twelve years after being first seen.

From these facts the impression may be gained that solitary myeloma of bone may have to be viewed as a separate and distinct clinical entity.[15] And yet it may be possible that all multiple myelomas begin as unrecognized solitary myelomas, and that by the time we recognize them (at least roentgenologically) they have already become generalized through metastasis. On the other hand, some pathologists believe that multiple myeloma is a systemic disease of the marrow and that metastasis plays no part in its development.[15] Whatever view may be taken, however, the important fact remains that establishing a diagnosis of solitary myeloma is important, since the solitary lesion is more amenable to therapy and has a more favorable prognosis.

In the case herein reported one cannot but speculate as to the length of time the lesion may have remained solitary and without generalization, had the patient lived. Yet the facts remain that the patient had a solitary myeloma of the right ischium from the time of his symptomatology to the time of his death, a period of almost one year, and did not develop any evidence of multiple myeloma. Roentgenograms of the skull, ribs, long bones (humeri and femora), spine and chest, usually the most common sites for multiple myeloma and the sites in which it appears earliest, were all negative for such evidence.

Another interesting feature in the solitary form is the pathological type of lesion found. In 57 of the 61 cases reviewed by Gootnick,[6] the plasma cell type predominated; the cell type in the remaining 4 cases was not stated. The case in this presentation also proved to be a plasma cell tumor. Whether this has anything to do with the more benignant course of these tumors has never been established. It must be stated, however, that pathologic reports indicate no essential difference between the solitary and multiple forms of myeloma. It seems entirely possible as emphasized by Paul and Pohle,[9] that myeloma may occur in varying degrees of malignancy, with generalization occurring early in some (typical multiple myeloma), and late or never at all in others.

Another significant point of interest in the discussion of solitary myeloma of bone concerns the occurrence in the urine of Bence-Jones protein. In only 20 per cent (9 cases) of the 45 cases of Paul and Pohle[9] was Bence-Jones protein present in the urine, a low incidence compared to the well known 50 to 60 per cent in the multiple form; and when it was found it was usually only after generalization had occurred. Gootnick[6] found the percentage even lower, the small number of early cases showing Bence-Jones protein being only 4 out of 41 cases, or 10 per cent. In the solitary myeloma herein presented, diligent search was carried out for the protein, but it was found absent at all times.

From the roentgenological viewpoint two main types of lesions have been described. The first is a purely osteolytic, destructive lesion with sharp demarcation and little, if any, expansion. This type is most frequently located in a single vertebra or the shaft of a long bone and can easily be mistaken for an osteolytic, metastatic,

carcinomatous lesion. No proliferative bony changes are associated with this. The second type resembles a giant cell tumor of bone and is a multicystic, osteolytic lesion with rather sharp demarcation and occasional expansion. The area of destruction is crossed by irregular and sometimes rather thick trabeculae. In some of the cases destruction of the cortex is seen, but more commonly the cortex is intact. Pathologic fracture through the tumor is of frequent occurrence and in some instances is the incident which leads to the discovery of the lesion. This multicystic tumor was encountered in the pelvic lesions and in some cases in the long bones. This type appears to run a more benign course.

The significant point stressed in all this discussion is that because of the relative benignity of both types of the solitary form as compared with the multiple myeloma, strenuous efforts at eradication of the lesion must be effected, whether by surgical resection or irradiation. In regard to the latter, Gootnick's[6] statement is significant: "X-ray therapy following biopsy or curettage was carried out in 43 cases and appears to be the treatment of choice. It gave relief of pain and prolonged life several years beyond the average for multiple myeloma."

SUMMARY

The literature is reviewed and solitary myeloma of bone is found to be extremely uncommon. Only 61 cases have been recorded. To this is added another, and it is apparently the only case thus far reported involving solely the ischium of the bony pelvis. It proved to be a plasma cell type pathologically. The great majority of cases detailed in the literature also were found to be plasma cell tumors. In the case presented, Bence-Jones protein was never found in the urine. The incidence of occurrence of this protein in the urine of solitary plasmocytoma of bone is found to be relatively low as compared with the multiple myelomata; and when found it is usually after generalization has occurred. Clinically and roentgenologically, the solitary tumor of bone runs a more benign course, and because of this is more amenable to therapy and has a more favorable prognosis.

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THE RECOGNITION AND SIGNIFICANCE OF BACTERIOGENIC GAS IN THE SOFT TISSUES*

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CLASSICAL gas gangrene is infrequently encountered in modern American medical practice. When it occurs, the diagnosis is usually made on clinical and bacteriologic grounds. The roentgenological manifestations are well known and will not be discussed here.

Gas may be generated by bacterial growth in the body tissue, without the systemic evidences of gas gangrene. Cooke, *et al.*[1] discuss cases of this sort under the heading of "Potential Gas Gangrene." Sachs,[2] in his comprehensive résumé of the subject, states that gas gangrene must be subdivided into several clinical types. The groups of "acute fulminating gas gangrene" and "gas gangrene of muscle" constitute the disease usually called to mind by the term "gas gangrene." The groups "gas abscess" and "subcutaneous gas infection" refer to disease processes in which the acute prostration of gas gangrene is absent. In these cases, the roentgenologist may play an important rôle. The recognition and careful study of such gas generation frequently serves to establish the presence and location of deep-seated abscess, or infected hematoma. The discovery of a collection of small gas bubbles in the soft tissue or within solid viscera may lead to the diagnosis of unsuspected devitalized tissue infections in locations of surgical importance.

It is the purpose of this paper to:

1. Emphasize the characteristic roentgenographic appearance of bacteriogenic gas in the soft tissues. (Classical gas gangrene is a distinct entity and is not discussed in this paper.)

2. Show the surgical significance of such gas.

3. Demonstrate similar gas generation in blood clots inoculated with organisms recovered from actual war wounds.

CLASSIFICATION OF SOFT TISSUE GAS

Soft tissue gas shadows are frequently seen by the roentgenologist. Usually they are of no clinical significance, but this is by no means always the case. The presence of gas may constitute an important finding, serving as an indication for, and a guide to, surgery.

Gas in the soft tissues, as seen by the roentgenologist, may be classified according to its origin, as follows:

1. Exogenous: Outside air which enters the body through a sinus tract, through a surgical incision, or at the site of skin-penetrating trauma.

2. Endogenous: Gas which escapes from a hollow viscus.

3. Bacteriogenic: Gas which results from the breakdown of devitalized tissue by the action of bacteria. The soft tissue gas of classical gas gangrene belongs to this category. The gas in this group differs from that in 1 and 2 in the following ways:

   a. It appears spontaneously instead of as an immediate result of trauma or surgery. A roentgenogram taken as late as four weeks after an injury may begin to show gas while the earlier roentgenograms did not.
   b. The outline and location of the gas do not correspond to anatomic boundaries, as is found following the rupture of a hollow viscus, *i.e.* the change in position of the gas abscess shadows is limited by the abscess wall. The gas shadows resulting from rupture of a hollow viscus may migrate to the limits of the peritoneal cavity.
   c. It is first seen as small, spherical radiolucent bubbles.
   d. The bubbles may be grouped around an opaque or a non-opaque foreign body.
   e. Serial roentgenograms disclose an increase in the amount of gas if the infection is not controlled.
   f. The bubbles frequently become larger, change position, and coalesce.

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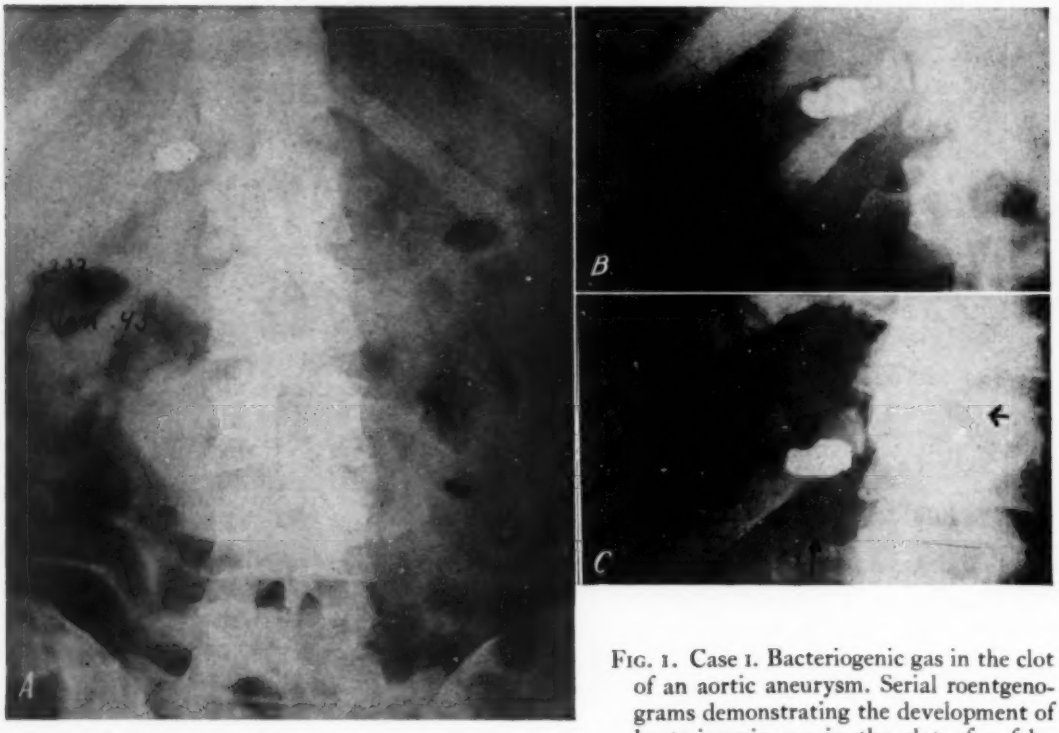

FIG. 1. Case I. Bacteriogenic gas in the clot of an aortic aneurysm. Serial roentgenograms demonstrating the development of bacteriogenic gas in the clot of a false aneurysm of the aorta. The metallic fragment seen in the right upper quadrant, entered the left flank, and penetrated the aorta. The roentgenograms were taken on the twentieth (*A*), twenty-sixth (*B*), and the thirtieth (*C*) day after injury. Note the absence of gas on the twentieth day and the marked increase in the extent of the gas shadows between the twenty-sixth and the thirtieth day.

g. Single or multiple gas fluid levels may appear.
h. Trapped gas may reveal the shaggy "roof" of a well walled abscess.

REPORT OF CASES

CASE I. White male, aged twenty-seven, wounded on December 13, 1944. A 15 mm. fragment entered the left flank. On December 14 a laparotomy was performed at a forward hospital. The postoperative notes mentioned hemoperitoneum, subperitoneal hematomas, penetrating wound of the mesocolon in the region of the splenic flexure, and a rent in the posterior parietal peritoneum with a lacerating wound of the lower pole of the left kidney. No metallic fragment was seen at the time of operation. Roentgenograms taken on January 2, 1945, demonstrated a 15 by 8 mm. metallic fragment just behind the expected position of the duodenal bulb. No gas was seen about the fragment. On January 8 a 2 cm. ring of small gas bubbles was noted surrounding the metal foreign body. Roentgenoscopy on January 9 demonstrated both diaphragms normally movable. The fragment moved about 1 cm. on respiration. At the last examination, on January 12, 1945, sponge-like gas shadows covered a radius of 7 cm. about the metallic fragment (Fig. 1). Beginning on January 6 the patient complained of pain in the right flank. Beginning at about that same time he developed a spiking fever which reached 102° F. He died on January 15. Necropsy revealed that the shell fragment had passed through the abdominal aorta. There was a large degenerated hematoma related to the aortic perforation in front of the kidney and protruding forward into the pouch of Morison. The metallic fragment was found in the center of the degenerated clot. The degenerating hematoma corresponded accurately to the size and position of the group of small gas bubbles demonstrated by roentgenograms.

CASE II. White male, aged twenty-two, wounded on December 22, 1944. A 20 mm. fragment struck the upper back. He developed a

right hemopneumothorax, which was drained by the closed method on December 28. Chest roentgenogram taken on December 31 revealed a pocketed right hemopneumothorax. The metallic fragment was seen projected through the right axilla in the posteroanterior view. No gas bubbles were seen about the fragment. There were fractures of the right third and fourth ribs posteriorly. The wound in the back healed during the first ten days. Beginning about January 1, 1945, a lump appeared in the right axilla and gradually increased in size. The patient had spiking fever which gradually rose to 103° F. by January 12. There was pain in the right shoulder during this interval, but he did not appear acutely ill. On January 12 the blood pressure was 60/40 in the right arm and 120/60 in the left arm. A bruit was heard over the right upper pectoral area. A diagnosis of early aneurysm of the subclavian artery was made. Roentgenograms of the right shoulder taken on January 12 revealed a 12 cm. halo of gas bubbles surrounding the metallic fragment (Fig. 2). On January 14, the right axilla was explored and a false aneurysm of the artery thoracalis lateralis was found. The center of the associated clot was necrotic and contained the metallic fragment. *Clostridium welchii* was cultured from the wound. (The cultures of *Cl. welchii* used in the bacterial studies recorded below were from this case.) The position of the necrotic clot corresponded exactly with the gas shadows noted on the roentgenogram.

Fig. 2. Case II. Bacteriogenic gas in an axillary aneurysm. Bacteriogenic gas developed in the clot of a false aneurysm of the lateral thoracic artery. A roentgenogram taken on the tenth day after injury demonstrated no gas shadows about the metallic fragment. The roentgenogram shown here was taken on the twenty-second day after injury. At subsequent surgery, *Clostridium welchii* was cultured from the clot.

Fig. 3. Infected clot in a thigh wound. Bacteriogenic gas was demonstrated in a thigh wound sixteen days after injury. At subsequent surgery, *Klebsiella* and *Clostridium welchii* were cultured from the abscess.

Other Cases in Brief Form: The remaining cases in which bacteriogenic gas was found will not be recounted in detail but will only be mentioned briefly to illustrate the representative sites at which the gas shadows were seen.

Typical of cases of bacteriogenic gas in extremities is that of an infected clot in a wound of the thigh. The roentgenogram shown in Figure 3 was taken sixteen days following injury. The patient was at no time acutely ill and his temperature never exceeded 102.2° F. Wound cultures grew *Klebsiella* and *Clostridium sporogenes*. The gas shadows served as a guide to the surgical treatment.

Figure 4 demonstrates the appearance of the right lateral chest wall sixteen days following surgical debridement and repair of a wound of the lateral chest wall and subjacent diaphragm. The surgical closure had healed promptly. The patient became slightly ill on the eighth postoperative day and ran a low grade fever (below 100° F.). Roentgenograms demonstrated multiple gas shadows in the region of the previ-

FIG. 4. Gas abscess in the lateral chest wall. Bacteriogenic gas resulting from the growth of *Clostridium welchii* in a wound of the lateral chest wall.

ous surgical repair. Incision and drainage of a large subcutaneous and subdiaphragmatic abscess was performed. *Clostridium welchii* was cultured from the wound at this second operation. Prompt recovery ensued.

Figure 5 was taken from a case in which an infected clot led to the discovery of a radiolucent foreign body. Transperitoneal surgery shortly after injury by mortar fire had disclosed a laceration of the superior pole of the right kidney and minor intraperitoneal damage. The roentgenogram shown here was taken twenty-five days later in an attempt to explain a mild chronic fever. The subsequent surgery revealed that the gas bubbles were within a degenerated clot surrounding a surgical sponge. The gas abscess was in relation to the superior pole of the right kidney.

IN VITRO DEMONSTRATION OF SIMILAR GAS SHADOWS

An experiment was devised to demonstrate the production of similar gas shadows in the laboratory. Fifty cubic centimeters of sterile citrated human blood was placed in each of twelve latex condoms. This container was chosen to combine elasticity with radiolucency. Each blood sample was then inoculated with 0.01 cc. of a pure culture of an organism isolated from an infected war wound. The blood was clotted by means of calcium gluconate. These cultures in blood clot were then incubated at 37°C. Needle hubs in the top of the sterile containers permitted the escape of excess gas. Horizontal ray roentgenograms were made of the several cultures at eight hour intervals. Figure 6 and Table 1 show the result of this experiment. The growth of organisms in each inoculated culture was checked by stained smears taken from the blood clot after the last roentgenogram had been made.

Note that the small bubbles in this simple demonstration are similar to those seen in vivo.

In the roentgenograms taken at thirty-two hours, the bubbles are larger and float upward as the clot becomes liquefied. This imitates the liquefaction with resultant gas fluid level formation sometimes demonstrable in vivo.

FIG. 5. Gas abscess surrounding a surgical sponge left in the right perirenal space for twenty-five days (arrows). Intravenous urogram. The metallic foreign bodies are superficial and not in the abscess.

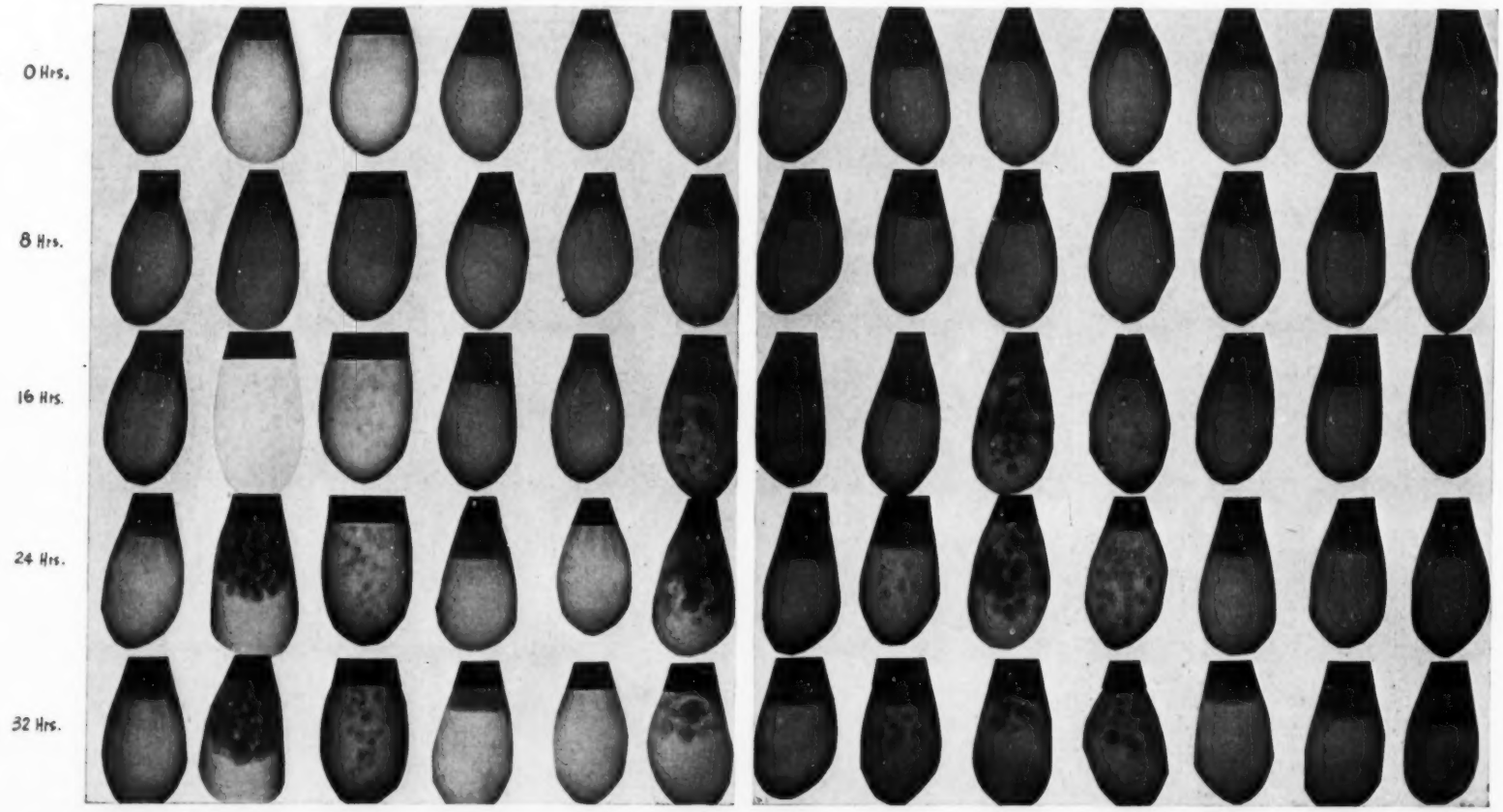

FIG. 6. Horizontal ray roentgenograms of blood clots inoculated with a variety of war wound organisms. Fifty cubic centimeter portions of sterile, citrated human blood, in radioparent containers were inoculated with a variety of pure cultures derived from war wounds. After the specimens were clotted with calcium gluconate, they were incubated at 37° C., and horizontal ray roentgenograms made at eight hour intervals. Note the pattern of gas bubbles formed by *Clostridium welchii*, *Clostridium butyricum*, *Klebsiella*, and *Proteus*. Note also the similarity of the pattern of these gas shadows to that of the gas shadows seen in the cases demonstrated.

DISCUSSION

Characteristic roentgenographic shaddows are produced in blood clot or in devitalized tissue by a variety of organisms.

In practice, the recognition of bacteriogenic gas shadows is most valuable in deep locations inaccessible to palpation. In our series, unsuspected abscesses were discovered in the retroperitoneal tissues, in the subdiaphragmatic space, and in the deep tissues of the axilla by means of roentgenograms. The typical sponge-like shadows are also found in the liver, where their presence invariably indicates hepatic abscess. The most frequent site for bacteriogenic gas is in clotted infected hemothoraces. In this location, however, its recognition is less vital due to the ease of diagnosis by thoracentesis.

Table I

Organism	Amount of Gas Produced
Control—no inoculum	None
Clostridium welchii	Much
Clostridium sporogenes	Little
Clostridium difficle	None
Clostridium multifermentans	None
Clostridium butyricum	Much
Clostridium carnis	None
Escherchia coli	Little
Klebsiella	Much
Proteus	Much
Hemolytic staphylococci	None
Pseudomonas	Little
Alcaligenes	None

An increase in the amount of gas about a metallic foreign body is positive evidence of infection. This statement can be made on the basis of surgical findings in our cases. Grouped sponge-like gas shadows may form about an infected non-opaque foreign body, thus indicating its position. Gas bubbles are not demonstrable in all infections, but the finding of such gas may be accepted as reliable evidence of infection. The gas bubbles must not be taken as an indication of the presence of clostridia because laboratory and case studies have shown that these shadows are produced by a variety of other organisms.

Of the wound contaminants tested in the laboratory, the following were found to produce gas: (a) *Escherichia coli;* (b) *Klebsiella;* (c) *Proteus;* (d) *Clostridium welchii;* (e) *Clostridium sporogenes;* (f) *Clostridium butyricum.*

In certain cases where mixed infections were found to form gas in wounds, the pure cultures of single organisms did not produce gas in vitro. The gas formation observed in vivo was evidently the result of symbiotic metabolism.

CONCLUSIONS

Bacteriogenic gas in the soft tissues or within solid organs is a valuable roentgenological finding.

Gas shadows of a characteristic roentgenographic pattern are evidence of infection, usually in blood clot or in devitalized tissue.

Gas bubbles similar to those seen in vivo can be produced in the laboratory by growing certain organisms in clotted human blood.

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EDITORIALS

RENAL PATHOLOGY IN THE LIGHT OF RECENT NEUROVASCULAR STUDIES

FOR YEARS the kidney has been the subject of considerable study both as regards its anatomical structure, its physiology and the pathological changes incident to it in disease processes. Various methods of study have been utilized in an approach to the elucidation of some of the pathological processes in which the kidney plays an important part.

In 1945 Trueta[1] stated that the renal anoxia found in a number of pathological conditions was probably "the result of overstimulation of the vascular nerves," and with that conception, he and certain of his colleagues have lately begun "what we hope will be a full-scale experimental study of the effects of direct, central, and reflex stimulation of vascular nerves upon the various organs of the body."

At a recent meeting of the Physiological Society in England, Trueta, Daniel, Barclay and Franklin[2] made a preliminary report on "Renal Pathology in the Light of Recent Neurovascular Studies." In this report they called attention to the fact that with appropriate nerve stimulation in animals both with the abdomen unopened and in those in which the kidney had been exposed, the renal blood flow may be diverted from its commonly accepted course, and as a result the cortex of the kidney may be partly or wholly deprived of its blood supply.

In their studies they utilized roentgenographic methods and demonstrated these changes in a most striking manner. They found (as a result of the application of a tourniquet for a number of hours to the left hind leg) that the left renal circuit time was shortened by virtually a half, though the caliber of the renal artery was at the same time reduced by a quarter. The only possible explanation of these simultaneous effects was, in their opinion, a vascular short circuiting.

Further proof of this conception of short circuiting of the circulation was obtained in laparotomized animals after various types of nerve stimulation. They observed the blue color of the blood in the renal vein changed partially or wholly to red. In some animals the appearance of the red blood was observed to be accompanied by pulsations of arterial type. They also observed that red stream lines appeared in the renal vein after the renal cortex had paled and while it still remained pallid, and that dyes injected into the arterial side of the circulation appeared in the renal vein but did not stain the surface of the kidney, and on section the cortex was seen to be unstained while the medulla, and especially its subcortical part, was deeply colored by the dye.

These observations made on the left kidney were in marked contrast to the right unstimulated kidney in which both cortex and medulla were stained. The former, namely the cortex, was more deeply stained than the medulla. These observations made with the use of dyes were confirmed by roentgenographic methods. Radiopaque substances injected into the abdominal artery above the renal arteries revealed the vascular supply of the right renal artery extending into the cortex, whereas in the left kidney the vascular supply as demonstrated roentgeno-

[1] Trueta, J. *Lancet*, 1945, *2*, 415.

[2] Trueta, J., Daniel, P., Barclay, A. E., and Franklin, K. J. Renal pathology in the light of recent neurovascular studies. *Lancet*, 1946, *2*, 237–238. Editorial comment. The lesser circulation of the kidney. *Lancet*, 1946, *2*, 239–240.

graphically had failed to reach the cortex.

From these experiments and roentgenographic observations the investigators drew the conclusions that as a result of appropriate nerve stimulation the blood supply may be diverted wholly or partly from the cortex and short circuited through medullary (especially subcortical) blood channels. The large potential capacity of these by-passing channels enables them to transmit the whole of the renal blood inflow whenever the supply to the cortex is diverted and the latter thereby rendered ischemic.

In order to locate these by-passing channels histologically, particulate material was injected in place of dyes and was found to fill the vasa recta and their loops, as well as a subcortical plexus of vessels, suggesting that these two sets of vessels were the anatomical channels involved.

As a result of their researches, Trueta and his associates have shown that in the experimental animal a renal circulation can be continued through the medulla while the cortex is functionally ischemic and that during this period the flow of urine through the ureter may be decreased or entirely suppressed.

The experimental work conducted thus far stresses the great importance of the mechanism by which a temporary or permanent cortical ischemia may be produced without arrest of the renal circulation.

Also from their experimental observations it seems probable and most likely that nerve stimulation could be produced centrally or peripherally by a variety of noxious agents and that the picture seen in many loosely related syndromes such as "sulfa kidney," incompatible transfusion kidney, Weil's disease, and some forms of nephritis, is the result of a defense device by which the cortex of the kidney is excluded from the circulating toxin or other noxious agent, and thus protected. Quite naturally, too prolonged operation of the device may result in permanent damage to the cortex.

These observers think that as a result of their experimentation this same protective mechanism may fulfill another role in hemorrhage and shock or conditions with decreased blood volume by preventing the blood from reaching the filter of the kidney, namely the cortex, and thus conserving fluid.

This concept of the "lesser circulation of the kidney" has obvious physiological, pathological and clinical implications, and Trueta and his associates suggest that in the light of such recent experiments the interpretation of renal function tests must be reconsidered and they hypothecate that hypertension and its explanation which has been the goal of so many experimenters may be the result of disordered activity of some nerve center or centers from which impulses are sent to the same vascular effector organs as are involved in the cortical ischemia and medullary congestion which they have observed in their nerve stimulation experiments.

At the conclusion of their report they express the hope that their experimental work will soon be made possible in book form. Such fundamental experimentation and the implications as set forth in their recent publication are awaited with considerable interest by the medical and scientific world.

It is of extreme interest that some of the most striking observations which were made during their experimental studies were those in which the roentgen ray was used. Quickly upon the heels of the report of Trueta and his colleagues on the circulation in the kidney, Donnelly[3] added clinical evidence in confirmation of this experimental investigation. This observation was made in routine intravenous pyelographic studies on four men and each showed absence of function on one side. The first two showed normal function on both sides at the examination repeated after forty-eight hours. In neither case was there evidence of calculus formation or other abnormality. It was thought that the unilateral cessation of function prior to the first examination was due to the restriction of fluids combined

[3] Donnelly, B. Circulation in the kidney. *Lancet*, 1946, *2*, 362.

with excessive sweating in the hot climate in which the studies were made. In the light of the paper by Trueta and his colleagues, Donnelly was forced to conclude that these cases were examples of the device whereby the cortex of a kidney is excluded from the renal circulation, consequent upon diminished blood volume; that is, that the altered kidney function was simply the result of diminished fluid intake in otherwise normal subjects in a hot climate, indicating that the lesser circulation of the kidney is a protective mechanism. In many instances in certain disorders of the body economy this protective mechanism may be prolonged to such an extent as to do permanent damage to the renal cortex.

These fundamental experiments which Trueta and his collaborators have instituted may and probably will lead to an elucidation of a host of diseases in which the kidneys play an important part.

CARL F. DICK
1878–1946

DR. CARL F. DICK was born July 19, 1878, at Cannelton, Indiana. His early childhood was spent in this location and his preliminary education was obtained there. In 1897 he entered the Medical School of Vanderbilt University from which he graduated in 1901. After graduation he returned to Evansville, Indiana, where he entered the private practice of medicine.

While he was still in school the discovery of the X-ray by Röntgen had attracted his interest and it was only natural that with the continued development of this new medical agency he became more and more impressed with its possibilities. His interest was not so much from the standpoint of the radiologist but more from that of the manufacturer and distributor.

In 1905, he became associated with William Hettick in the sale of Schiedel-Western X-Ray equipment and soon after he obtained the agency for the sale of Kelley-Koett equipment with his headquarters in Indianapolis, Indiana.

In 1919, he moved to St. Louis and organized the St. Louis X-Ray Supply at 4221 Olive Street, and in 1923, incorporated his business as the Dick X-Ray Company of St. Louis, at 3974 Olive Street where he continued in business until his death.

He was a pioneer in the roentgen-ray industry and always showed the keenest interest in advances in this field. He was in a key position to give material aid to many young radiologists as they embarked upon their careers and his passing will be regretted by his host of friends.

On October 20, 1946, Dr. Dick died from a coronary lesion; carefree and contented, without regrets, he died as he had lived.

L. R. SANTE

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Haddon Hall, Atlantic City, N. J., Sept. 16–19, 1947.

American College of Radiology
Secretary, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting: 1947, to be announced.

Section on Radiology, American Medical Association
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: 1947, to be announced.

American Radium Society
Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: Seaside Hotel, Atlantic City, N. J., June 9–10, 1947.

Alabama Radiological Society
Secretary, Dr. John D. Peake, Mobile Infirmary, Mobile Ala. Next meeting time and place of Alabama State Medical Association.

Arkansas Radiological Society
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Palmer House, Chicago, Ill., Dec. 1–6, 1946.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

Section on Radiology, California Medical Association
Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Robert M. Lowman, Grace-New Haven Community Hospital, New Haven 11, Conn. Meets bimonthly on second Thursday, at place selected by Secretary.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

Radiological Section, Los Angeles Co. Med. Assn.
Secretary, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Brooklyn Roentgen Ray Society
Secretary, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

Buffalo Radiological Society
Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

Chicago Roentgen Society
Secretary, Dr. T. J. Wachowski, 310 Ellis Ave., Wheaton, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

Cleveland Radiological Society
Secretary, Dr. Carroll C. Dundon, 11311 Shaker Blvd., Cleveland, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

Dallas-Fort Worth Roentgen Study Club
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

Denver Radiological Club
Secretary, Dr. W. C. Huyler, 1619 Milwaukee, Denver 6, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Florida Radiological Society
Secretary, Dr. J. M. Dell, Jr., 333 W. Main St., S., Gainesville, Fla. Meetings in May and November.

Georgia Radiological Society
Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

Illinois Radiological Society
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. J. A. Campbell, Indiana University Hospitals, Indianapolis 7. Meets second Sunday in May.

Iowa X-Ray Club
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

Kentucky Radiological Society
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

Long Island Radiological Society
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

Louisiana Radiological Society
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

Michigan Association of Roentgenologists
Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

Milwaukee Roentgen Ray Society
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association, the other in the fall.

Nebraska Radiological Society
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Neb. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library

NEW HAMPSHIRE ROENTGEN RAY SOCIETY
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

RADIOLOGICAL SOCIETY OF NEW JERSEY
Secretary, Dr. W. H. Seward, Orange Memorial Hospital, Orange, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA RADIOLOGICAL SOCIETY
Secretary, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

NORTH DAKOTA RADIOLOGICAL SOCIETY
Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

CENTRAL NEW YORK ROENTGEN RA SOCIETY
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

OHIO RADIOLOGICAL SOCIETY
Secretary, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.

OKLAHOMA STATE RADIOLOGICAL SOCIETY
Secretary, Dr. P. E. Russo, 230 Osler Bldg., Oklahoma City, Okla. Three regular meetings annually.

ORLEANS PARISH RADIOLOGICAL SOCIETY
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC ROENTGEN SOCIETY
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. C. L. Stewart, Jefferson Hospital. Meets first Thursday of each month, October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY
Secretary, Dr. L. M. J. Freedman, 115 South Highland Ave. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

PORTLAND ROENTGEN CLUB
Secretary, Dr. Selma Hyman, University of Oregon Medical School, Portland, Oregon. Meets monthly 2d Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY
Secretary Dr. A. M. Popma, 220 N. First St., Boise, Idaho.

ST. LOUIS SOCIETY OF RADIOLOGISTS
Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

SAN DIEGO ROENTGEN SOCIETY
Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

SAN FRANCISCO RADIOLOGICAL SOCIETY
Secretary, Dr. Joseph Levitin, 516 Sutter St., San Francisco 2, Calif. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

SHREVEPORT RADIOLOGICAL CLUB
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

SOUTH CAROLINA X-RAY SOCIETY
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

UTAH RADIOLOGICAL CONFERENCE
Secretary, Dr. Henry H. Lerner, School of Medicine, University of Utah, Salt Lake City 1. Meets 1st and 3rd Thursdays monthly from 7:30 to 10 P.M., Salt Lake County General Hospital, September to June.

UTAH STATE RADIOLOGICAL SOCIETY
Secretary, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

VIRGINIA RADIOLOGICAL SOCIETY
Secretary, Dr. E. L. Flanagan, 116 E. Franklin St. Richmond, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY
Secretary, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

X-RAY STUDY CLUB OF SAN FRANCISCO
Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE ROENTGEN SOCIETY
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

FACULTY OF RADIOLOGISTS
Secretary, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Keith Hallam, St. George's Hospital,

K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

Canadian Association of Radiologists
Honorary Secretary, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, Que. Meetings January and June.

Société Canadienne-Francaise d'Électrologie et de Radiologie Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

South America

Sociedad Argentina de Radiologia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306 Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

Continental Europe

Ceskoslovenská společnost pro röntgenologii a radiologii v Praze
Secretary: MUDr. Roman Blána, Praha XII, Korunní 160, Czechoslovakia.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. Babaiantz, Geneva.
Secretary for German language, Dr. Max Hopf, Effingerstrasse 49, Bern. Meets annually in different cities.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

SECOND INTER-AMERICAN CONGRESS OF RADIOLOGY

The First Inter-American Congress of Radiology was organized by the Argentine Radiological Society and held in Buenos Aires in 1943, under the Presidency of Dr. José F. Merlo Gómez. Havana was selected as the meeting place for the Second Inter-American Congress of Radiology, and the Cuban Radiological Society was constituted the Committee of Arrangements. The dates of the meeting were November 17–22, 1946. Dr. Pedro L. Fariñas was elected President, with Dr. R. Hernández Beguerie as Secretary General, Dr. Eduardo Rivero and Dr. Rafael A. Gómez as Assistant Secretaries, Dr. Ernesto Fonts as Treasurer and Dr. Armando Cabrera and Dr. C. Rodríguez Remus as Vocales. Honorary presidents included Dr. Grau San Martín, President of the Republic of Cuba, a physician, his Secretary of Health, the Rector of the National University, the Dean of the Medical School, as well as Dr. José F. Merlo Gómez, President of the First Inter-American Congress of Radiology.

The opening meeting of the Congress was presided over by the Cuban President, Dr. Grau San Martín. Speakers of the evening included Dr. José F. Merlo Gómez, Dr. Pedro L. Fariñas, and the writer. Drs. Gómez and Fariñas emphasized the international character of the science of radiology and the great good which these meetings were accomplishing. Delegates numbering some six hundred and fifty, including members of their families, were in attendance at the meeting. Over three hundred were from the United States.

The general program covered four and one-half days, Monday to Friday noon, with eighty-three formal papers and a large, very interesting and instructive scientific exhibit as well as a large, well-organized and attractive commercial exhibit. During the current year most of the papers will be published, some of them *in extenso* in this Journal, others as abstracts after they have appeared in other publications. Each contributor to the program of the meeting was given the privilege of having his paper published where he chose. In addition, it is the plan of the Cuban Committee to publish all the papers in a single volume.

The local committee deserves high praise and a general expression of gratitude for their courteous efforts to entertain the

visiting radiologists and their ladies. There were special luncheons, beach parties, a typical country picnic with a luncheon of characteristic Cuban dishes, together with an interesting entertainment; sightseeing tours, numerous private entertainments and parties.

Seventeen of the eighty-odd papers listed in the program were contributed from the United States and six from Canada. The afternoon discussions were centered about four principal topics, one for each afternoon: cancer of the stomach, bone tumors, bronchogenic cancer, and roentgenological mass investigations of the lungs.

The exhibits were especially interesting, particularly worthy of mention being those by Felix Leborgne and his colleagues from Montevideo and by Aguirre and his colleagues from Cuba on mastography. Bronchography was the theme of several extensive exhibits, particularly that of Di Rienzo of Argentina; Molinari of Argentina; Rivero of Cuba, whose theme related chiefly to children; Veulens of Cuba; Aguirre and Martel of Cuba; and Mata Martinez of Ecuador. Angiocardiography and other examinations involving visualization of blood vessels was the theme of exhibits by Raúl Pereiras and A. Castellanos; Viamonte and colleagues, Pedro L. Fariñas, and Boladeres all of Cuba. The small intestine was extensively illustrated by the exhibits of H. P. Doub, Luis Fariñas and H. Beguerie, and Milanés. Numerous exhibits on bone pathology included those of Corsellas of Buenos Aires; Bailey of the United States; Coley and Higinbotham of the United States; Maissa of Argentina; Inclán of Cuba; Soto of Peru as well as Lemone and Ackerman of the United States and Cardenas Pupo and Sanchez Toledo of Cuba.

The second evening of the meeting was devoted to a "solemn session" in commemoration of Röntgen. Dr. Edith H. Quimby, of New York, discussed "Atomic Energy and Medicine." In brief, she said that atomic energy in the form of radiations resulting from atomic disintegration is a very useful agent in new work in many fields of science, including biology and medicine. There are two broad types of use of these substances. In *therapy* the purpose is to produce some change in living cells; the important thing is the radiation from disintegrating atoms; the nature of the atom is only of importance insofar as its chemical nature makes it possible to localize the substance in a particular region. In *tracer* work the radioactivity is only a tag or label; it is essential that there should not be enough of it to bring about any chemical or physiological change. The important thing is that chemically, radioactive and nonradioactive atoms of the same substance behave in the same manner and cannot be separated. Hence the admixture of a very small amount of radioactive isotope of any element, with a considerable quantity of the stable form, makes it possible to follow the course of the whole mixture through the body.

In therapy, at the present time, these substances offer little advantage over standard roentgen-ray and radium procedures, except in a few very special cases. It is possible that in the future, new methods and techniques will be developed which offer greater promise.

With tracers, a large amount of very important work is being done on metabolic functions, cell behavior, and many other topics. Some of these studies are of tremendous significance in furthering scientific knowledge. All of these artificially radioactive substances are potentially dangerous to anyone handling them, and it is most important that precautions be taken to prevent radiation injuries to workers in any field where they are employed.

Dr. Quimby should be complimented on her clear, slow diction, lucid presentation, and graphic illustrations.

Dr. G. Esguerra Gómez, of Colombia, gave a splendid oration on Röntgen. He pleaded for the conservation of the terms "roentgen diagnosis," "roentgen therapy," and "curie therapy," in order that the names of Röntgen and Curie might not be

forgotten. Another oration by Dr. Leonardo Guzmán on Röntgen terminated the evening's program.

Honorary Fellowships in the American College of Radiology were conferred upon Dr. Pedro L. Fariñas and Dr. J. Manuel Viamonte of Cuba; Dr. Felix Leborgne of Montevideo and Dr. José F. Merlo Gómez of Argentina, and *in absentia* upon Dr. Manóel de Abreu of Brazil.

In the closing session of the Congress it was voted to hold the next meeting in Santiago, Chile, in 1949, with Montevideo, Uruguay, named as second choice in case for any reason the meeting cannot be held in Santiago at that time. It was also voted to establish an Inter-American College of Radiology, with Dr. Pedro L. Fariñas, of Havana, as President, and Dr. R. Hernández Beguerie of Havana, as Secretary. It is planned that the officers of each Inter-American Congress of Radiology shall constitute the officers of the College for the succeeding three years, and that the College shall be given the responsibility of arranging the Inter-American Congresses of Radiology.

James T. Case

AMERICAN COLLEGE OF RADIOLOGY

The annual meeting of the American College of Radiology will be held at Haddon Hall in Atlantic City on Sunday, June 8, 1947. The annual councilors' luncheon will be held at noon on Sunday, June 8. The annual meeting will take place in the afternoon and will be followed by the annual banquet and presidential address.

NEBRASKA RADIOLOGICAL SOCIETY

At the annual meeting of the Nebraska Radiological Society held in Omaha, in October, 1946, the following officers were elected for the ensuing year: *President*, Dr. D. A. Dowell, Omaha, Nebraska; *Secretary-Treasurer*, Dr. O. A. Neely, Lincoln, Nebraska.

RADIOLOGICAL SECTION

At the recent meeting of the Radiological Section of the Los Angeles County Medical Association the following officers were elected for the coming year: *President*, Dr. Roy W. Johnson; *Vice-President*, Dr. R. L. Fielder; *Secretary*, Dr. Moris Horwitz; *Treasurer*, Dr. Wilbur Bailey.

CANCER TEACHING DAY

A Cancer Teaching Day was held at Troy, New York, on December 12, 1946. The following papers were presented:

Dr. Hayes Martin, New York, Mouth Cancer.
Dr. Cushman Haagensen, New York, Tumors of the Breast.
Dr. Louis C. Kress, Buffalo, Tumors of the Bone.
Dr. Richard B. Cattell, Boston, Malignant Tumors of the Gastrointestinal Tract.
Dr. Harold W. Dargeon, New York, Tumors in Children.

SYMPOSIA ON CERTAIN NEOPLASTIC AND INFLAMMATORY DISEASES

The Commission on Education of the American College of Radiology in cooperation with the Philadelphia Roentgen Ray Society will conduct a post graduate course in Philadelphia, March 30 through April 4, 1947. The course will cover the diagnosis and treatment of certain neoplastic and inflammatory diseases. The instruction officers will include many of the outstanding teachers in the United States. For information write to the American College of Radiology, 20 North Wacker Drive, Chicago 6, Illinois.

DEPARTMENT OF TECHNIQUE

Department Editor: ROBERT B. TAFT, M.D., B.S., M.A., 103 Rutledge Ave. Charleston, S. C.

A SIMPLIFIED METHOD OF PRODUCING THE AXIAL VIEW OF MAYER IN CHRONIC MASTOIDITIS AND ATTIC CHOLESTEATOMA

By GILBERT ROY OWEN, M.D.
LOS ANGELES, CALIFORNIA

THE orthodox views in cases of chronic mastoiditis are often of relatively little value. In these views, the mastoid antrum is largely obscured by the labyrinth in its dense housing. The tympanic cavity is represented by a round area of diminished density produced by the superimposition of the external auditory canal and tympanic cavity, on the one side, upon the vestibule and internal auditory canal on the other. Topographic views of the antrum are obtained by other recognized methods, but by no other method than that of Mayer is the fine detail of the attic-aditus-antrum area obtained, and by no other method can the integrity of the anterior and posterior walls of the external auditory canal be determined. Unfortunately, this view has been designated at times as the Mayer position for study of the petrous process, though the petrous portion of the temporal bone is actually distorted and the greatest use of the position should be for study of the attic and antral areas.

FIG. 1. *1*, root of zygomatic arch; *2*, head of mandible; *3*, tympanic bone; *4*, labyrinthine area; *5*, area of mastoidal tip; *6*, petrosa; *7*, internal auditory canal; *8*, cochlea; *9*, internal carotid canal; *10*, lateral sinus; *11*, antrum; *12*, the tympanic cavity sharply limited by the external auditory canal, and limited above by the dome of the attic; *13*, styloid process; *14*, ossicles.

Figure 1 is a composite of a Mayer roentgenogram and an original Mayer line drawing. Here, the position, the result of a 45° cephalocaudal projection, plus a 45° ventrodorsol rotation of the head, is faithfully reproduced. Mayer has suggested that slight deviations from this pattern are sometimes not disadvantageous. Frequently, when the epitympanum was of primary concern, we have found this to be true.

While the visibility of the antrum suffers from the fact that the angle of the projection and the German horizontal used is too small, the condition of the area of the attic can usually be evaluated better because its lumen as well as the auditory bones and the upper margin of the annulus tympanicus are better recognized. Concerning the projection variants one can say that shifting of the tube dorsally is less disadvantageous than ventrally.[1]

To clarify the composite drawing (Fig. 1) we have used as a model in our instruction

[1] Otologische Röntgendiagnostik, pp. 73–74.

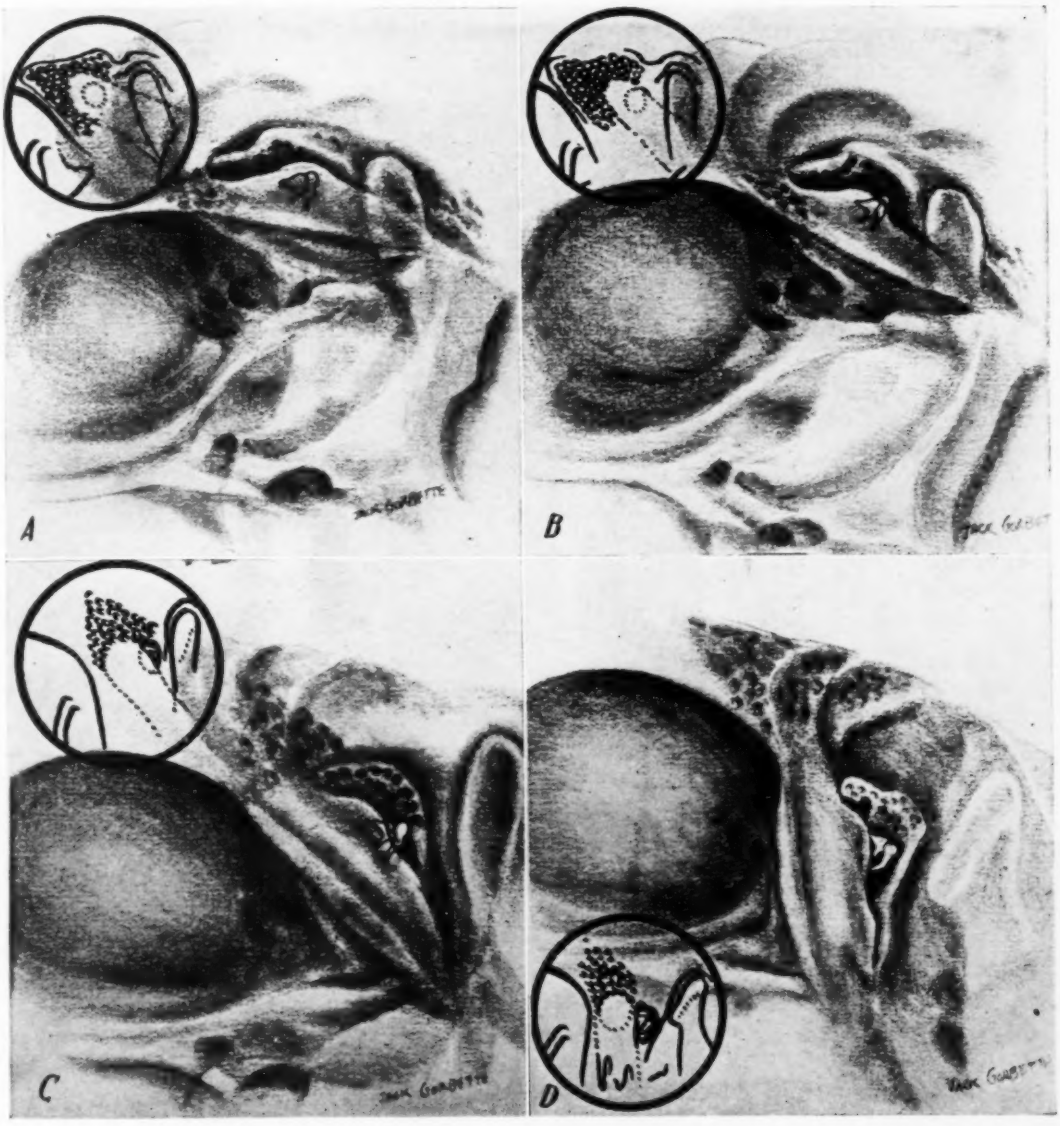

Fig. 2. *A* was drawn from above, looking downward and outward at a 15° angle, as in the primary Law position. The ossicles are indicated beneath the shadow of the labyrinth, which also obscures the antrum. The lateral sinus and the small area of pneumatization are in evidence. The head of the mandibular ramus has been brushed in for orientation.

B. A 35° angle was used, directed downward and outward (Schüller). The antrum is still obscured by the labyrinth. A portion of the head of an ossicle is seen, and the obliquity of the petrous crest has increased.

C. The angle from above and downward has been increased to 45°, the primary Mayer position. Note the increased surface of the cellular area and the change in the obliquity of the petrous crest. The ossicles, in part, and a suggestion of the tympanic and epitympanic areas have been attained.

D. The 45° angle of *C* has been retained, and the model has been rotated 45° ventrodorsally. The close apposition of the surface of the mastoid with the cassette remains undisturbed. The tympanic cavity and the ossicles are seen and the osseous pattern of the lateral wall of the attic can be seen in detail. The antrum cannot be seen in the drawing, but in the corresponding film it is in relief. The lower half of the sinus plate is confluent with the posterior margin of the petrosa.

courses at the annual mid-winter convention of the Research Study Club, a sagittal half-skull from which the antral-epitympanic roof has been removed. We have

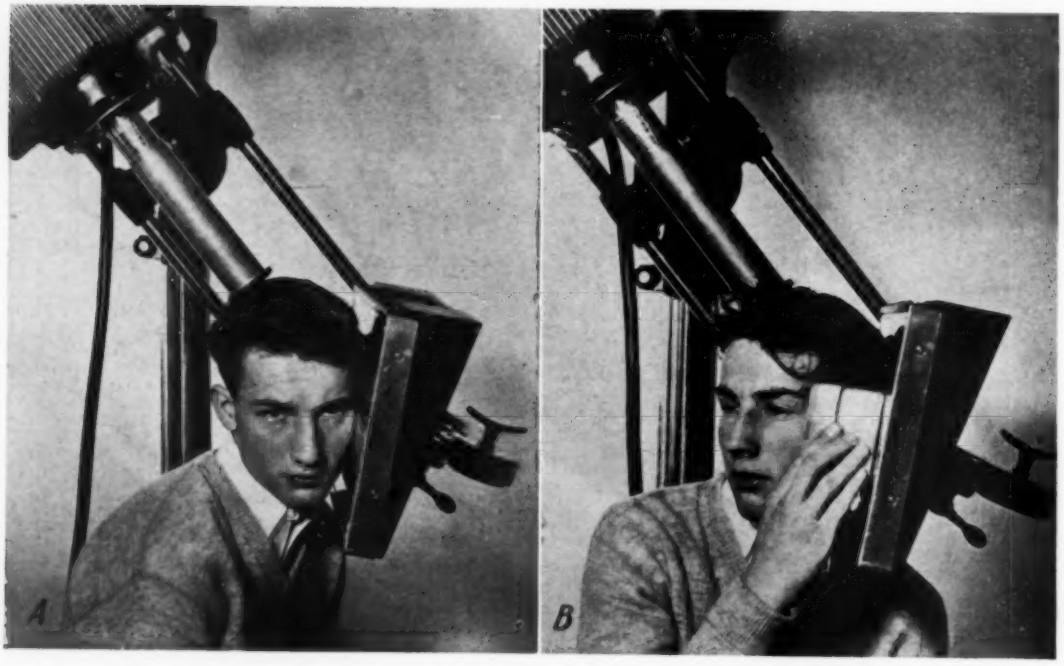

Fig. 3, *A* and *B*.

Fig. 4

attempted to reproduce such a demonstration in a series of four drawings, to illustrate the evolution of the Mayer position. In this series of drawings (Fig. 2, *A*, *B*, *C* and *D*) the model was posed in the upright position, that in which the patient is placed for the roentgenogram.

plished by allowing the shoulder to rotate under the cassette tunnel without disturbance of the close mastoid-to-cassette apposition. The central aperture, through which the film is exposed, is cut through a lead plate and the film may be exposed at its center, or the right and left halves, at

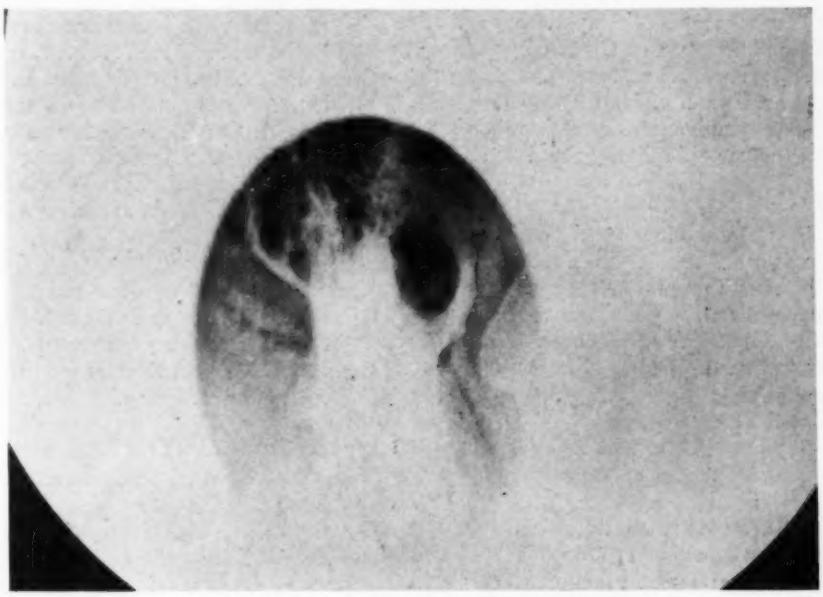

Fig. 5

The roentgenogram taken in Mayer's position is not as difficult to interpret as it is to produce in a laboratory committed to a large volume of work. Measurement scales, protractors, plumb-bobs and gadgets in general are not conducive to accurate and readily reproduced work. By the use of the simplified method (Fig. 3, *A* and *B*) the patient sits erect in a comfortable position. The apparatus is adjusted to the patient—not the reverse. The cassette tunnel used is an adaptation of the GE Reflex Cassette Tunnel. The positioning is done by the mirror and cross method, the central beam being focused on the cross, as is the area to be studied. The tunnel is just large enough to contain the smallest cassette that can hold an 8×10 inch film, plus the extra width necessary to permit a one-half lateral shift of the cassette. In Figure 3*A* the angle is 45° cephalocaudad. This angle is retained in Figure 3*B*, and the 45° ventrodorsal rotation is readily accomwill (Fig. 4). Thus, we may have the right and left mastoids on the same film or a stereo of one side, as may seem desirable. We have found it useful, at times, to use the small mastoid cone on one side of the film, and by changing to a smaller cone gain added detail on the other (Fig. 5).

We submit the drawings with the hope that they may be helpful in the interpretation of the projection under discussion. The 45° angle dorsoventral rotation, which frees the antrum from the dense labyrinthine shadow and exposes the tympanic and attic areas, is made comfortable for the patient and easy for the technician by permitting the shoulder to rotate freely under the cassette-tunnel. Because of the fundamental angles developed and described by Mayer, the projection should bear his name, regardless of any simplification or modification.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

Gros, J. C. Plasmocytoma of the temporal bone. *Arch. Otolaryng.*, 1945, *42*, 188–190.

Plasmocytomas of the temporal bone are extremely rare. In the review of world medical literature, the author found only 2 other reported cases.

Summary of the Case Report. A case characterized by tinnitus and deafness, trigemenial pain and paralysis of the fifth and sixth cranial nerves was observed. A plasmocytoma was discovered in the temporal bone, involving the middle ear, the mastoid and the petrous apex. There was a pronounced radiosensitivity of this tumor to high voltage roentgen radiation.

Comment. Plasmocytic mastoiditis was described by Eagleton as a metaplasia of the bone marrow originating in a suppuration of low virulence in the petrous apex and filling the mastoid process with plasmocytes. This classification apparently did not apply to the author's case since there was no growth in the cultures and since there were definite morphologic differences between the plasmocytes present in the sections taken and the typical plasmocytes.

In the present stage of knowledge it is difficult to determine whether a plasmocytoma of the face and skull or of the airways is a primary manifestation of multiple myeloma or if it corresponds to a solitary tumor. It is impossible to determine whether the growth will remain benign or become malignant. The absence of Bence-Jones protein is not, according to New, an important factor, and it is interesting to note that patients who may react in different ways do not show many great differences in the histopathologic examination. As in the case reported, these different clinical forms have a plasmocyte as a predominant cell. Its size may vary, sometimes being two or three times larger than normal with more than one nucleus and mitosis. Mitosis does not indicate malignancy, for in the 3 cases reported by Hellwig in which there was mitosis there was no recurrence after operation.—*Mary Frances Vastine.*

Byars, Louis T., and Sarnat, Bernard G. Surgery of the mandible: the ameloblastoma. *Surg., Gynec. & Obst.*, 1945, *81*, 575–584.

The ameloblastoma develops from the cells of the enamel organ during a particular phase of tooth development. It is found most frequently in the mandible, less so in the maxilla, and occasionally in the pituitary gland, tibia, ulna, and ovary. For the purposes of this report only the ameloblastomas of the mandible are considered. Although the tumor is considered uncommon there have been over 400 reported. Both sexes are affected in about equal frequency.

The ameloblastoma is generally described as a benign neoplasm although in a study of 379 tumors, 4.5 per cent showed metastases or histologic evidence of malignancy. A better known characteristic of this tumor is its persistence and tendency to "recur" after operative intervention. The tendency for the ameloblastoma to "recur" locally is probably due to inadequate surgical treatment.

Diagnosis

1. *Clinical findings.* The ameloblastoma, which is most frequently seen in young adults, is characterized by a slow progressive swelling of the jaw, usually near the angle. The tumor may sometimes become very large and weigh several pounds. There may be accompanying pain. There is usually a history of a tooth or teeth having been extracted from the area several years previously and of several attempts to surgically eliminate the tumor. Fistulous tracts leading to the oral cavity and secondary infection of the tumor are not uncommon.

The buccal plate of bone is usually expanded most although the lingual bone may be expanded to push the tongue to the opposite side of the mouth. The bone is sometimes so thinned that it will crack like an eggshell. These are late findings after the tumor has changed from the solid to the cystic phase. The patient may be seen only after pathologic fracture has occurred. Only occasionally do true signs of malignancy appear.

2. *Roentgenographic findings.* The roentgenogram is most valuable for the early diagnosis of ameloblastomas of the jaw when the tumor is still centrally located, has not expanded the bone, and is in the solid phase. It is at this time, when most of the mandibile is as yet not destroyed, that the tumor can be removed completely with no serious deformity. When the ameloblastoma has become cystic and considerably larger, the clinical findings are obvious and the roentgenogram is of primary value in showing the extent of bone destruction. There is no constant characteristic roentgenographic description of the ameloblastoma. The multilocular appearance and the scalloped border are by no means pathognomonic. The ameloblastoma, giant cell tumor, carcinoma and other lesions which are destructive cannot be positively differentiated from each other on the roentgenogram.

3. Curettement, cauterization with drugs, and irradiation are inadequate therapeutic measures. The lesion should be (1) completely enucleated if unilocular, (2) cauterized by heat if not too large and multilocular, or (3) if extensive, resected, including a small amount of normal bone. These are the best methods of treatment because they give the greatest assurance of complete removal of the tumor.—*Mary Frances Vastine.*

MARTIN, HAYES, and EHRLICH, HARRY E. Papillary cystadenoma lymphomatosum (Warthin's tumor) of the parotid salivary gland. *Surg., Gynec. & Obst.*, 1944, *79*, 611–623.

Papillary cystadenoma lymphomatosum does not constitute a serious or complicated problem in a tumor clinic. These benign tumors cannot be differentiated from mixed tumors of the parotid by clinical examination alone, and, in most cases, a specific diagnosis is not made until after a surgical specimen has been examined.

The present study was undertaken to determine the clinical behavior of these tumors and is based upon a series of cases of papillary cystadenoma lymphomatosum culled from the record of 359 parotid tumors, all observed in the Head and Neck Service of the Memorial Hospital from 1932 to March 1944, inclusive.

Definition. The term, "papillary cystadenoma lymphomatosum," designates an essentially benign cystic tumor occurring either in, or attached to, the parotid salivary gland. Its microscopic appearance is characterized by specific epithelial structures supported by a lymphoid stroma. Other terms that have been employed to designate this neoplasm are adenolymphoma, branchiogenic adenoma, epitheliolymphoid cyst, branchioma, cylindrocellular branchiogenic adnoma, orbital inclusion adenoma, and onkocytoma.

Etiology

Incidence. The 22 cases of papillary cystadenoma lymphomatosum, herein reported, comprise 10 per cent of benign parotid tumors, 6 per cent of all parotid tumors, and less than 2 per cent of all neoplasms of the head and neck seen in the Memorial Hospital.

Age and Sex. The oldest patient was seventy-three years of age and the youngest was thirty; the average age was about fifty-three years. There were 20 males and 2 females. Thus the tumor may be seen to occur characteristically in middle aged and elderly males.

Pathology

Gross. This is an encapsulated tumor. The capsule is thin, strong and glistening and traversed by fine blood vessels. When cut, the tumor exudes a chocolate-colored mucinous material. Usually the cut surface is coarsely lobulated and contains several cysts. These cysts are lined with shaggy tissue composed of papilliferous projections and sometimes the locules are completely filled with papillary tissue. The shaggy appearance of the lining of the cysts is the most striking naked eye characteristic of cystadenoma lymphomatosum.

Histopathology. Microscopically, the tumor is characterized by papillary epithelial structures embedded in a lymphoid stroma. The papilliferous projections are covered by a peculiar eosinophilic, palisade-like epithelium and, together with its supporting lymphoid stroma, are the most striking histologic features of this neoplasm.

Symptoms and Clinical Course. Most of the patients complained of no symptoms other than cervical or facial disfigurement. The tumors were located most frequently in the midportion of the parotid or, in other words, just in front of the lobule of the ear. The clinical course is essentially benign.

Diagnosis. There are no clinical stigmas sufficiently characteristic of papillary cystadenoma lymphomatosum to distinguish it from certain other much more common tumors of the parotid.

Differential Diagnosis—(1) mixed tumor of the parotid, (2) branchiogenic cyst, (3) malignant lymphoma, (4) cervical adenitis, (5) metastatic carcinoma, (6) cystic carcinoma of the parotid.

Sialography—The general roentgenographic appearance produced by papillary cystadenoma lymphomatosum was not diagnostic or specific. The findings consisted mainly of slight displacement or distortion of part of the duct system.

Aspiration biopsy—This procedure was performed in 18 cases. In 12 cases, a report of papillary cystadenoma lymphomatosum was returned by the pathologist.

Treatment. The treatment is by surgery, the tumor being enucleated by sharp and blunt dissection along its capsular wall.

Radiation Therapy—Inasmuch as the tumor contains abundant lymphocytic components, the question as to its possible radiosensitivity and a preference for radiation therapy might be raised. On the other hand, the character of the lymphoid tissue, the presence of the adenoid elements, and the cyst formation, do not augur well for the success of radiation therapy. It has been fairly definitely established that hyperplastic lymphoid tissue, in general, is not highly radiosensitive and will not regress under irradiation unless the dosage is high. The question is of little practical import, however, since the results of surgery are so expeditious and satisfactory as to leave almost no indication for any other method of treatment.

Recurrence—In this series of 21 surgical excisions, there have been no local recurrences to date. The tumor does recur, however, if not completely excised.—*Mary Frances Vastine.*

NECK AND CHEST

Boots, Edmund C. 35 mm. films in diagnosis of chest conditions. *Ann. Int. Med.*, June, 1943, *18*, 997–998.

As part of a program of the School Health Department of the Pittsburgh public schools serving approximately 130,000 children, the author tested with tuberculin 40,000 children, took 8,000 roentgenograms and found 44 clinically active cases.

This method is recommended for mass survery work. It is not applicable where only a dozen or so chests are roentgenographed in the course of the day. It is of value where film storage is at a premium and the 8,000 films stored for reference occupy a space approximately the size of an ordinary file drawer. A single film costs less than 4 cents, where a 14″×17″ film would cost 6 cents. With 35 mm. film the photoroentgenograms can be taken in approximately 1/10 the time and at 1/10 the cost.—*James J. McCort.*

Banyai, Andrew L., and Cadden, Anthony V. Diabetes and tuberculosis. *Arch. Int. Med.*, Dec., 1944, *74*, 445–456.

An analysis of the reports of ten American clinicians based on the observations of 17,358 cases of diabetes indicates a higher incidence of tuberculosis in diabetic persons than in the general population of the United States. A complexity of causes may bring about the increased susceptibility of the diabetics to tuberculosis. The authors believe that hypovitaminosis A may have a significant role in this respect. In their own sanatorium they found, however, the number of patients with diabetes and pulmonary tuberculosis is far below the estimated number of tuberculous diabetic persons.

The fact that an unusually high percentage of diabetic patients who acquire tuberculosis are not adequately treated for their pulmonary disease before it reaches the far advanced stage calls for an urgent revision of the diagnostic approach to this problem.

For the recognition of early tuberculosis it is necessary to anticipate this disease. (1) All diabetic patients should be tested with tuberculin and the test should be repeated periodically on all patients with negative reactions to tuberculosis. (2) A roentgenogram of the chest should be taken of all patients with positive reactions at least once a year. Adequate search for tubercle bacilli should be carried out when sputum is available or when roentgenologic observations justify repeated aspirations of the fasting gastric contents.—*James J. McCort.*

Sweet, Richard H. An analysis of Massachusetts General Hospital cases of lung abscess from 1938 through 1942. *Surg., Gynec. & Obst.*, June, 1945, *80*, 568–574.

The last report on lung abscess from the Massachusetts General Hospital showed evidence of improvement in the results of treatment during the five year period, 1933 through 1937, as compared with those of earlier reports. Sufficient time has now elapsed to include a

two year period of follow-up after the next five year period, 1938 through 1942, and this report is offered for comparison with that of the preceding five year period.

Conclusions. Although lung abscess continues to be a serious disease, there has occurred over the past ten or more years an encouraging increase in the number of cures and a gratifying reduction in the mortality rate.

The data presented suggest that this improvement in the results of treatment is probably not due to the influence of the administration of the sulfa drug chemotherapeutic agents.

The improved results, if not due to a diminution in the virulence of the infection in the average case, are most likely accounted for by a greater knowledge of the disease and a better understanding of the principles of treatment.

The fact that the management of these cases in the Massachusetts General Hospital has for many years been the responsibility of a very small group may be of significance.—*Mary Frances Vastine.*

VALLE, ANIBAL ROBERTO. Lung abscess; analysis of 244 cases. *Surg., Gynec. & Obst.*, Sept., 1945, *81*, 278–286.

The author presents a review of 244 cases of lung abscess, some of which were treated surgically and some nonsurgically. The conclusions which he considers worthy of note are:

1. A precise localization of the abscess is very important in determining the method of approach in cases in which surgery is contemplated. Roentgen examination and bronchoscopy are particularly useful in this respect. Lipidol is of little use in the localization of the abscess since it seldom enters the cavity itself.

The most prevalent site of the abscess was the right lower lobe, the next the left lower lobe, and the next the right upper lobe.

2. Forty-one abscesses developed after tonsillectomies, and 27 after abdominal operations, all performed under general anesthesia (usually ether). In 23 per cent of the cases in children, lung abscess was caused by aspiration of a foreign body.

3. In cultures of sputum, material obtained by bronchoscopic aspiration and the material from the abscess itself, both aerobic and anaerobic organisms were found. Pneumococci were most frequently found and less often *Staphylococcus aureus*, fusiform bacilli, hemolytic streptococci, *Micrococcus catarrhalis*, etc.

4. In regard to symptomatology, the earliest and most frequent symptom was found to be cough, dry at first and later becoming productive. Eighty-eight per cent had foul sputum, 11.4 per cent had odorless sputum, and 57.8 per cent had hemotysis. Chills and fever were found in 90 per cent of the cases and chest pain in 94 per cent.

5. In the cases reviewed, 154 were male and 90 female, 208 adult, and 36 children. The average age of the adult patients was 35.9 years and the children ranged between one month and thirteen years.

6. The average duration of the disease in these cases was one year.

7. The following are considered as possible preventives of lung abscess following surgery: (*a*) good care of teeth, gums and throat before a contemplated operation; (*b*) avoidance of the use of strong sedatives before and after operation; (*c*) frequent aspiration of the trachea and bronchial tree by nasal catheter; (*d*) encouraging the patient to cough after operation; (*e*) early aspiration bronchoscopy in a postoperative atelectasis.

8. In acute cases the abscess should have surgical drainage as soon as it is diagnosed.

9. In some chronic cases conservative treatment is tried first and, if the patient does not improve sufficiently with this treatment, operation is performed.

10. Surgical drainage is created by several methods depending on the location of the abscess. In cases of peripheral abscess with empyema a thoracostomy is performed with additional enlargement of the opening in the lung by cautery if necessary. Thirty-seven thoracostomies for associated empyema were performed. In cases with more deeply situated abscesses, the cautery procedure is carried out. Total unroofing of the cavity, with resection of the overlying ribs is done. (General anesthesia is used in all surgical procedures.) Needle aspiration is helpful in accurate localization of the abscess after the pleura is exposed. The pack is allowed to remain in the abscess cavity about five days. It is changed, the first time, under general anesthesia. Thereafter, the pack is changed every other day and applied more loosely to allow the lung to re-expand.

In some cases in which the cavity does not heal completely and bronchial fistulas remain over a considerable period of time, a lobectomy

is performed. There are 28 lobectomies in this series and 2 total pneumonectomies.

11. The postoperative complications that were encountered included hemorrhage, spillover, empyema, septic spread of the disease involving the subcutaneous tissues of the body, kidney, spleen, and brain. Bronchopleurocutaneous fistulas sometimes require plastic operation, Schede thoracoplasty, or lobectomy for obliteration.—*Mary Frances Vastine.*

Figi, Frederick A., Broders, Albert G., and Havens, Fred Z. Plasma cell tumors of the upper part of the respiratory tract. *Ann. Otol., Rhin. & Laryng.*, 1945, *54*, 283–297.

Myelomas are usually defined as tumors arising in bone marrow. However, there is considerable question whether classic multiple myeloma is an intrinsic disease of the bone marrow or a disease of the blood-forming structures generally. Solitary plasma cell myelomas or plasmocytomas may be of extra-osseous origin; such neoplasms at times develop in the upper part of the respiratory tract as well as elsewhere in the body. The cause and nature of these tumors and their relationship to multiple myelomas are not definitely known.

This report is based on a study of 11 cases of solitary plasma cell myeloma of the upper part of the respiratory tract which were observed at the Mayo Clinic in a period of fourteen years.

Multiple myeloma generally occurs in the fourth or fifth decade and usually causes death in a few months to four years. The neoplasm is considered by most authors to be a hypertrophic tumor of the hematopoietic system, usually of the bone marrow. However, the hematologic picture usually is not affected until the later stages of the disease when more or less severe secondary anemia may develop. Bence-Jones proteinuria is present in approximately 80 per cent of cases. This is in contrast with the situation existing in cases of plasmocytoma, in which Bence-Jones protein is rarely if ever present in the urine prior to the development of multiple osseous lesions.

Sex, Age and Sites of Occurrence in Plasma Cell Myeloma. These tumors occur more often in males than in females.

They are usually not seen in patients under forty years of age.

Extramedullary plasmocytomas most frequently are seen about the pharynx, palate, nose and accessory nasal sinuses. They may originate in any portion of the upper part of the respiratory tract.

In the present series of cases, the site of the tumor was as follows: in the maxillary sinus in 6 cases, the oropharynx in 2 cases, the nasopharynx in 2 cases and in the larynx in 1 case.

Although the exact cause of this type of tumor is not definitely known, it is generally thought that it develops from the small and large lymphocytes.

Signs and Symptoms. In most of the cases symptoms were present for less than six months before the patient was seen. Swelling of the cheek, nasal obstruction and frontal headache were the most common symptoms encountered.

Pathology—Gross. The tumor appeared highly malignant in most of the cases. In a few instances the mass had a polypoid appearance. Ulceration was usually not present unless there had been previous treatment. In all of the cases in which there was primary involvement of the maxillary sinus, the findings were indicative of a malignant neoplasm.

Clinical evidence of involvement of the regional lymph nodes was noted in only 1 of the cases in this series.

Roentgenographic Studies. In cases in which the neoplasm involved the accessory sinuses, roentgenographic examination frequently showed much more extensive involvement than was suspected from the clinical findings. In several instances a tumor that appeared clinically to involve only the maxillary sinus and nasal fossa was found by roentgenographic examination to be present in the ethmoid cells and frontal sinus as well.

In only 1 of the 11 cases was metastatic involvement of bone demonstrable roentgenographically at the time of the primary examination. Roentgenographic examination of the maxillary sinus disclosed not only extensive destruction of the upper jaw, maxillary sinus and ethmoid cells but what appeared to be multiple areas of metastatic destruction throughout the skull as well.

On the basis of their experience, the authors believe that plasmocytomas are malignant lesions.

These tumors are very rare. Of the 625 cases of malignant growths of the nose and accessory sinuses seen at the Mayo Clinic during the past

fourteen years, there were only 6 cases of plasma cell myeloma. Among the more than 1,600 malignant neoplasms of the larynx seen at the Clinic there has been but 1 case of plasma cell myeloma.—*Mary Frances Vastine.*

MOERSCH, HERMAN J., TINNEY, WILLIAM S., and MCDONALD, JOHN R. Adenoma of the bronchus. *Surg., Gynec. & Obst.*, Nov., 1945, *81*, 551–558.

Mueller, in 1882, described the first case of bronchial adenoma. His patient had complained of hemotypsis and expectoration of purulent material for eight years. At postmortem examination a pedunculated adenoma was found in the left main bronchus with numerous bronchiectatic cavities distal to the neoplasm.

In this article the authors present their experience in 38 consecutive cases of adenoma of the bronchus encountered at the Mayo Clinic. They reach the following conclusions:

1. Adenoma of the bronchus is a relatively common tumor involving the tracheobronchial tree.

2. It occurs usually among younger person than does carcinoma of the bronchus and, in contrast to bronchiogenic carcinoma, is more common among women than among men.

3. It is generally slow growing and usually gives rise to clinical symptoms over a much longer period than carcinoma of the bronchus before the diagnosis is established.

4. In the authors' experience cough is the most frequent and earliest symptom of adenoma of the bronchus. Hemoptysis, asthmatoid wheeze and recurrent bouts of pulmonary infection are other common symptoms.

5. Adenoma of the bronchus generally presents a characteristic bronchoscopic picture, but the final diagnosis must rest on microscopic examination.

The tumor mass can at times be clearly outlined by tomographic studies and at times can be outlined if a roentgenogram is made after the bronchi have been filled with iodized oil. A region of atelectasis is indirect evidence of bronchial obstruction and should cause one to suspect an endobronchial tumor. In 72 per cent of this series of cases an obstructing lesion of the bronchus was suspected on roentgenographic examination.

6. Adenoma of the bronchus presents a characteristic microscopic picture. Mitotic figures are usually absent. The type of cell is consistently a fairly small, roundish cell which does not have marked hyperchromatism of the nucleus. The tumor cells consistently make an attempt to form acini but are rarely very successful in the attempt. A noticeable feature of all adenomas of the bronchus has been their vascularity. In no instance in this series did metastasis occur to the other lung or outside the thoracic cavity. From their study the authors feel that adenoma of the bronchus should be regarded as a neoplasm of the lung sui generis.

7. The method of treatment to be employed in cases of adenoma of the bronchus depends on the situation of the tumor, the degree of secondary pulmonary suppuration and the patient's general condition. In the authors' experience endoscopic destruction of the tumor and destruction by surgical extirpation of the tumor by means of lobectomy or pneumonectomy are the most satisfactory methods of treatment.—*Mary Frances Vastine.*

LORENZ, EGON. Radioactivity and lung cancer; a critical review of lung cancer in the miners of Schneeberg and Joachimsthal. *J. Natl. Cancer Inst.*, Aug., 1944, *5*, 1–13.

Because of the growing belief in the United States and abroad that radiations emitted by radon inhaled for long periods of time or emitted from radioactive deposits in the lungs will cause cancer of lung in man, the author carefully reviewed the literature of lung cancer in relation to radioactivity particularly in the miners of Schneeberg, Germany and Joachimsthal, Czechoslovakia. Although this region is rich in radioactive substances, the radium content of the rocks in both mining districts and in the mines is relatively low. Exhaustive measurements in the mines showed only a possibility that radioactivity might play a rôle in the production of lung cancer. Some animal experiments which were poorly controlled indicated that radiations may cause the development of lung tumors, while other experiments clearly indicated that only fibrosis was produced in the irradiated lungs. Furthermore, reports of the luminous-dial painters who absorbed poisonous doses of radium showed only the development of bone sarcoma although they exhaled radon continuously. Other experiments of large doses of radiation to the lungs demonstrate only a resultant fibrosis and no development of carcinoma. The author concludes

that irradiation cannot be the sole cause of lung cancer because the intensity of radioactive substances found in the mines are within limits of safety, that some of the animal experiments showing production of tumors in the lung were poorly controlled and that there was no evidence from previous experience that alpha, gamma or roentgen irradiation produces neoplastic changes in the lungs.—*Harry Hauser.*

Fetter, Ferdinand. Carcinoma of the lung; a review of 31 proved cases at the Philadephia Naval Hospital. *Ann. Int. Med.*, June, 1943, *18*, 978–987.

In a twenty-one month period between January 1, 1941, and October 1, 1942, there were 31 proved cases of primary carcinoma of the lung admitted to the Naval Hospital in Philadelphia and 16 more cases in which this diagnosis was established to the satisfaction of all concerned, but in which microscopic proof was lacking.

There are unfortunately no symptoms or physical signs that are pathognomonic of carcinoma of the lung. In this series cough and sputum were the most common symptoms, being present in all but one of the patients.

All of the patients in this series showed abnormalities on roentgen examination of the chest. The most important roentgen finding suggesting lung cancer was atelectasis distal to the tumor, with accompanying shift of the mediastinum toward the affected side. This occurred in 65 per cent of the patients. Another type of lesion seen by roentgen examination is the single circumscribed lesion which is usually peripheral and beyond the reach of the bronchoschope. Fifteen per cent of the cases belonged to this group.

Methods of establishing the diagnosis: (1) bronchoscopic examination and biopsy, 45 per cent; (2) bronchography with iodized oil; it cannot establish the diagnosis but will indicate the presence of a tumor; (3) examination of pleural fluid for tumor cells; the diagnosis was thus established in only 1 out of 12 cases examined; (4) examination of the sputum for tumor cells; it did not establish the diagnosis in any case; (5) aspiration biopsy of the lung. This procedure is considered too hazardous; (6) exploratory thoracotomy. This was done in 2 cases of this series, both of whom were found to be inoperable; (7) biopsy from a metastasis. This established the diagnosis in 3 of the series; (8) autopsy. In 11 of the cases the diagnosis was finally established by this method.—*James J. McCort.*

ABDOMEN

Harris, Franklin I. Intestinal intubation in bowel obstruction; technique with a new single lumen mercury weighted tube. *Surg., Gynec. & Obst.*, Dec., 1945, *81*, 671–678.

In this communication, emphasis is placed on methods of improving the technique of intubation. It is based upon experience with 36 cases of small bowel obstruction in which intubation was used either as the only form of treatment or as preoperative or postoperative therapy.

Wangensteen and Dearing have classified intestinal obstructions into clinical groups showing which are suitable to treatment by (1) intubation alone: paralytic or adynamic ileus, e.g., postoperative or occasionally adhesive bands; (2) preoperative intubation and operation: various types of mechanical obstruction in early stages; (3) early operation and postoperative intubation: strangulating obstruction, e.g., mesenteric thrombosis, hernia, volvulus and intussusception.

Summary

1. The use of metallic mercury as a weight to facilitate the passage of a double or single lumen intestinal tube into the small bowel has been carried out in 36 cases of intestinal obstruction with but two failures.

2. A new simplified, calibrated, single lumen, mercury weighted tube is described for the purpose of intestinal intubation. It has the advantages of smaller total diameter, larger drainage lumen diameter, calibration to permit exact recording of the descent of the tube and simplified technique of introduction. It has been successfully used in 18 cases to date.

3. Progress of the tube and its favorable or unfavorable influence on the course of the obstructive process must be carefully checked by roentgenograms of the abdomen taken at frequent intervals. During the first forty-eight hours of an acute intestinal obstruction being treated by intubation, at least three films will have been taken approximately twelve to eighteen hours apart. If these films show favorable progress of the tube with deflation of the distended intestinal loops, the patient may

continue to be treated conservatively by intubation alone. If clinically and roentgenologically the patient is not doing well, or if the tube has not made satisfactory progress, the surgeon has not lost too much time in determining that operation is essential. In either type of case, the intestinal tube is not withdrawn until follow-up abdominal films show complete disappearance of any evidence of obstruction.

In treatment by intubation alone of the simple type of intestinal obstruction, the tube usually remains in place for from four to ten days.

4. Accidental rupture of the rubber bag containing the mercury has occurred in 2 cases, without evidence of mercurial poisoning.

5. Successful intubation by means of the mercury weighted technique seems to indicate that the principle of an air inflated bolus to stimulate peristaltic activity is unnecessary for progression of the tube into the obstructed small bowel. Gravity acting on a heavily weighted mercury tip accomplishes this result. —*Mary Frances Vastine.*

Cutler, George D., and Scott, H. William, Jr. Transmesenteric hernia. *Surg., Gynec. & Obst.*, Nov., 1944, *79*, 509–515.

The authors have assembled 46 well documented cases of transmesenteric hernia from the literature permitting a survey of 50 cases since they have 4 of their own.

The entire subject of intra-abdominal hernia was reviewed by Hansmann and Morton in 1939. These authors classified 467 reported cases of internal hernia according to the site of the hernial orifice and found 52 cases of transmesenteric hernia, 14 of which had openings in the ileocecal mesentery and 38 were found to have apertures located at higher levels in the small bowel mesentery. According to their statistics, transmesenteric hernia apparently constitutes about 11 per cent of all intra-abdominal hernias. In general, intra-abdominal hernias are relatively uncommon causes of acute intestinal obstruction.

Incidence. In this series of 50 cases, there were 29 males and 21 females. The youngest patient was four days and the oldest seventy-three years. The condition is fairly evenly distributed throughout early, middle, and late life.

Definition. Transmesenteric hernias are intraperitoneal hernias which have no sac but consist in the protrusion of a knuckle or loop of bowel through an aperture in the mesentery which may lead to intestinal obstruction and strangulation and subsequently to gangrene of varying lengths of intestine.

Etiology of Mesenteric Defect. Holes in the mesentery were not infrequently described by the early anatomists and pathologists. Mitchell states that these defects are met with about 1 in every 400 cadavers.

In the 50 cases under consideration defects were present in the mesentery of the ileocecal junction in 35 instances; in 6 individuals the openings were located at the mid-ileum, and in 2 in the jejunal mesentery. One patient had a defect in the mesosigmoid, and in another there were multiple fenestrations along the entire length of the mesentery. In the majority of instances the apertures were quite small, averaging only 2 to 3 cm. in diameter. In a few cases they were larger, the largest being 10 to 15 cm. They were usually circular or oval in shape with smooth, peritonealized edges.

There are several theories as to the etiology of defects in the mesentery: (1) Inflammation, particularly appendicitis. This hypothesis seems to lack proof. (2) Trauma. (3) Developmental or congenital causes. According to Treves, there is an avascular area in the mesentery of the ileocecal region circumscribed by the anastomosis between the ileocolic artery and the last intestinal artery supplying the terminal ileum. The mesentery in this region is poorly supported and contains neither fat, lymph nodes, nor visible blood vessels. It was here that he found defects in studying cadavers. Possibly there is an additional pressure on this avascular area by the rotation of the cecum in early embryonic life or stress exerted by the protrusion of the midgut into the umbilical celom.

Mechanism of Incarceration. It is probable that with the accidental prolapse of a knuckle of bowel through the ring-like opening distention results in a "gas trap" mechanism, and this is the force that draws loops of bowel through the aperture until incarceration occurs. Thus, the size of the hole does not limit the length of prolapsed bowel. Once incarceration takes place the familiar changes of intestinal strangulation leading to gangrene develop with the coincident clinical symptoms and signs of acute intestinal obstruction.—*Mary Frances Vastine.*

Jaleski, Thomas C. Pancreatic lithiasis. *Ann. Int. Med.*, June, 1944, *20*, 940–947.

Two cases of pancreatic lithiasis are reported. The first case is an alcoholic who showed early disturbance in the sugar metabolism, yet the pancreatic disease had not presented a serious threat to life. The second case succumbed to progressive disease of the pancreas, yet she was not an alcoholic and developed no serious disturbance in sugar metabolism until a few days before death.

Epigastric pain accompanied by diarrhea and steatorrhea was present in both cases. The association of alcoholism and pancreatic lithiasis in reported cases is thought to be too frequent to be coincidental. In one patient the attacks of pain, diarrhea and steatorrhea were often precipitated by excessive drinking.

One patient showed hyperglycemia with glycosuria, the other showed an abnormal sugar curve in the glucose tolerance test. However, it is not felt that the extent of disturbance of the carbohydrate metabolism bears any relation to the extent of the pancreatic disease or the prognosis. In neither case was there found an increase in the serum amylase and lipase.—*James J. McCort.*

Metheny, David, Roberts, Edward W., and Stranahan, Allan. Acute pancreatitis with special reference to x-ray diagnosis. *Surg., Gynec. & Obst.*, Nov., 1944, *79*, 504–508.

Between the years 1931 and 1943, 27 patients in whom a diagnosis of acute pancreatitis was established were admitted to the King County Hospital, Seattle. The diagnoses were proved either at operation or autopsy. Five other cases are included in the study since the diagnosis was considered to be a proved one by means of the blood amylase study and other typical findings as well as by roentgenograms.

The roentgen findings suggestive of acute pancreatitis are essentially three: (1) Tender tumefaction of the pancreas found during fluoroscopy. This is the most valuable finding as it is pathognomonic. (2) Changes in the stomach and duodenum. (3) Evidence of localized or generalized ileus.

The changes in the stomach and evidences of localized ileus are predicated upon the fact that the pancreas in acute disease is swollen to 2 or 3 times its normal size. It presses against the greater curvature of the stomach. The duodenum shows ileus, it has lost its tone, and the fluoroscopist will be able to push barium into it where it seems to hang and fails to be moved forward by peristalsis. The duodenal loop is also enlarged.

These changes can often be suspected in a preliminary roentgenogram with the patient supine. Occasionally there will be enough gas in the stomach to give the characteristic outline of the greater curvature near the pylorus. More frequently there will show a fair sized blob of gas in the cardia and another smaller one in the duodenal bulb. This is a very characteristic finding. Increased density of the pancreatic area may be observed. Also localized ileus, especially of the transverse colon or upper loops of jejunum, is observed. This is probably because the early pancreatic enzymes are starting to escape along the transverse mesocolon and root of the mesentery. Later, generalized peritonitis sets in and the picture of generalized ileus complicates the preliminary roentgenogram.

It must be remembered that not all impingements upon the greater curvature of the stomach are due to the pancreas. In one case, the preoperative diagnosis was cyst of the pancreas and the postoperative diagnosis was carcinoma of the gallbladder. The roentgen findings must be correlated with the clinical picture.

Symptoms and Signs. Every one of these 32 cases had a sudden acute onset with nausea and vomiting. They had epigastric pain and when seen early had no fever, a normal blood pressure and slow pulse. Tenderness was often so slight as not to be noticed by the examiner.

Every patient had albuminuria from a trace to 3 per cent. In general, these patients might suggest a ruptured peptic ulcer but they lacked the board-like rigidity. They might suggest an acute gallbladder except for the fact that they were too ill, or an acute coronary thrombosis but for the slow or normal pulse rate and blood pressure. Certain types of strangulated obstruction might make differential diagnosis difficult as acute pancreatitis must also be accompanied by a silent abdomen.

The patients with pancreatic necrosis were sicker than those with pancreatic edema. Their white blood count averaged 16,000 against 12,000 and the polymorphonuclear count averaged 85 to 90 per cent against 75 to 80 per cent. Jaundice was present only twice and in those instances it was associated with stone in the common duct.

In the edema cases, the blood amylase remained high as long as the disease lated, 18 days in one case. In the necrosis cases the blood amylase returned to normal in about two days. (The normal blood amylase reading is 8.)

Treatment. The authors have thought that the acute phase of the disease is best treated by nonoperative means. They also believe that roentgen therapy in small doses may be indicated.—*Mary Frances Vastine.*

BLAIN, A., III, GLYNN, T. P., and HIRATZKA, T. Dissecting aortic aneurysm involving a renal artery and simulating acute nephrolithiasis. *J. Urol.*, June, 1945, *53*, 753–761.

Morgagni reported the first case of dissecting aneurysm in the 18th century. Five hundred and seventy-three cases had been reported by 1944, of which only 56 had been diagnosed antemortem. At least 15 cases have been reported in which hematuria or other urological symptom was an important part of the clinical feature. The authors summarize these 15 cases, adding two cases of their own.

The first case was that of a sixty-one year old male who complained of a sudden onset of severe pain in the right costovertebral area, radiating to the groin and the midline of the back. There was a history of high blood pressure and two or three apoplectic strokes within four years. Physical examination revealed marked hypertension without residual paralyses from the previous cerebral catastrophes. A chest roentgenogram showed a widened heart and aorta, and a flat plate of the abdomen was essentially negative. The urine was loaded with red cells. The patient died suddenly about two weeks after admission. Autopsy revealed arteriosclerosis of the aorta with a dissecting aneurysm extending from the base of the left subclavian artery to the iliacs. The right renal artery was involved in the dissection.

The second case was a forty-seven year old colored male who had had hypertension for several years. He had a sudden onset of severe pain in the left costovertebral angle and beneath the sternum which radiated to the epigastrium and the left scapula. The patient had a marked hypertension, was in a profuse cold sweat and was tender in the left costovertebral angle. A chest roentgenogram showed cardiac and aortic enlargement. The correct diagnosis of dissecting aneurysm involving the left renal artery was made antemortem.

A review of these cases and of those reported in the literature indicates the importance of considering the diagnosis of dissecting aneurysm in patients with atypical urological symptoms. Patients with suggestive symptoms of urolithiasis with excruciating pain, sensory disturbances in the lower extremities, ecchymosis of the lumbar skin areas and with associated shock should be suspected of having dissecting aneurysms. The authors consider a negative flat film of the abdomen of importance. Atypical radiation of the pain is also of importance in considering a diagnosis of dissecting aneurysm as opposed to renal calculus. Males between the ages of forty-five and sixty-five with hypertension are especially to be considered for the former diagnosis.—*R. M. Harvey.*

OWENS, JAMES N., JR., and BASS, ALLAN D. Tuberculous aneurysm of the abdominal aorta. *Arch. Int. Med.*, 1944, *74*, 413–415.

This case report is presented as an instance of (1) tuberculous aneurysm of the aorta which was not associated with adjacent caseous nodes, and (2) an aneurysm in which acid-fast bacilli were demonstrated in the media of the vessel wall. This is the twenty-second reported case of tuberculous aneurysm of the abdominal aorta and to the knowledge of the authors the only case of blood borne infection. They believe that the acid-fast bacilli were disseminated through the blood stream as a result of the reactivation of the process in a hilar lymph node. It is also thought that the bacteria were transmitted to the media of the aorta via the vasa vasorum.—*James J. McCort.*

BISGARD, J. DEWEY. The ulcer carcinoma problem of the stomach. Editorial. *Surg., Gynec. & Obst.*, Dec., 1944, *79*, 673–675.

It is not generally appreciated that despite every available means of diagnosis it is impossible in an astonishingly large percentage of cases to differentiate early carcinoma of the stomach from benign gastric ulcer. From a study of 2,469 cases of carcinoma of the stomach at the Mayo Clinic, Walters, Gray and Priestley found that 37 per cent of the patients who had operable carcinomas of the stomach and 25 per cent of patients with inoperable lesions gave histories that were typical of benign ulcer, and, furthermore, the distressing fact that 80 per cent of the patients with carcinoma of the stomach who gave typical ulcer histories gained

temporary relief of symptoms from medical management. Unfortunately, relief on an ulcer regimen is often interpreted by both the physician and patient as confirmatory evidence of the benign character of the lesion, with the result that definitive treatment is delayed and the patient's chance of cure correspondingly reduced.

How is it possible to salvage by early resection this sizable important group of cases which masquerade as benign ulcers? To reach the largest number of cases at the earliest and most favorable time would necessitate resection of all ulcerating lesions of the stomach. A more conservative but less certain and less expeditious method is that of clinical trial. By this method all questionable cases are placed on a rigid ulcer regimen, preferably with bed rest for a period of three weeks. At the end of this time all patients who fail to obtain relief should be resected without delay. Certain of these refractory cases are benign ulcers but are sufficiently intractable to necessitate resection. All remaining patients, without exception and irrespective of relief of symptoms, should be re-examined roentgenographically. Carcinoma can be excluded with certainty only by evidence of progressive and final healing of the lesion in serial roentgenographic studies. It is not enough to demonstrate merely a reduction in the size of a crater but it is obligatory to carry out roentgenographic examinations every two weeks thereafter, until all evidence of the ulcer crater has disappeared. An ulcer regiman may cause a reduction in the inflammatory reaction around a carcinomatous ulcer and create the illusion that the crater has become more shallow and smaller. It goes without saying that all lesions which fail to regress or fail to heal after an initial regression should be resected.—*Mary Frances Vastine.*

Held, I. W., and Busch, Irving. Cancer of the stomach: with special reference to early diagnosis. *Ann. Int. Med.*, 1943, *18*, 719–735.

The authors divide cancer of the stomach into two groups. The first group comprises those cases in which the cancer starts on a perfectly healthy gastric membrane. In the second group the cancer develops on a previously diseased mucous membrane.

The rapid passage of food into the duodenum visualized roentgenologically is said to be an important finding in early cases of pyloric cancer. The pylorus presents a rigid tube which, however, is not irregular, so that unless the roentgenologist knows the clinical history, he may be unable to make a diagnosis of cancer from the roentgen examination alone.

In scirrhous carcinoma of the entire stomach or "leather-bottle" stomach, the authors find the stomach is transversely placed, well above the umbilicus. Fluoroscopically, the barium is seen to pass through so rapidly that within a half or three-quarters of an hour, the entire stomach is empty. The air bubble is very small or entirely absent. The fundus is either absent or very small. Often the barium is regurgitated into the esophagus, and the esophagus and stomach appear as two tubes.

In some 30 per cent of cases the cancerous lesion is said to develop on a previously diseased mucous membrane. This group comprises patients who have had gastric complaints for many years before cancer developed. The precancerous symptoms vary in nature and are usually very bizarre and non-characteristic, and are therefore interpreted mostly as neurogenic. There are three separate groups of clinical entities on the soil of which the cancer develops: (1) gastritis, (2) polyps, and (3) gastric ulcer.

What should be the criteria in determining whether an ulcer has become cancerous? It seems to the authors that the most stress should be placed on the greater persistence and aggravation of symptoms. Pain becomes worse and is not relieved by the intake of food, appetite diminishes, and there is a gradual loss of weight. In these cases, above all, gastroscopy with biopsy must be done.

Since many of the cases of gastric cancer are accompanied by a marked anemia this should be analyzed carefully. The hyperchromic type of anemia co-existing with achylia in a case of carcinoma simulates the picture of pernicious anemia. The diagnosis of carcinoma having been established, it is necessary to introduce liver therapy besides blood transfusions and iron. The hypochromic type of anemia should respond to blood transfusions and iron. In rare instances, the presence of a high degree of anemia may lead one to suspect actual bone marrow involvement due to metastases.—*James J. McCort.*

Womack, Nathan A. The origin of cholecystitis. Editorial. *Surg., Gynec. & Obstet.*, Oct., 1944, *79*, 441–444.

One of the very important contributions of

the late Edmund Andrews was the culture of the bile and the wall of normal gallbladders, the flora being compared with a similar group of acutely diseased and chronically diseased gallbladders. He and Henry were able to demonstrate that both quantitatively and qualitatively there was but little difference in the cultures of gallbladders of all types, including those with acute inflammation and those that were microscopically normal. Often in acute cholecystitis the badly damaged gallbladder wall was found to be sterile, as was the contained bile. This has been the author's experience also. By these observations, the fact is established that often the gallbladder like many other organs in the body is normally a contaminated viscus. This premise being true, injury to such a viscus would probably be followed many times by true bacterial infection. How is this initial injury sustained?

Because of the very frequent association between obstruction of the cystic duct and acute cholecystitis, it occurred to the author and his associates that the substance obstructed, namely bile, must play an important part in the production of this inflammation. Experiments were conducted on dogs and it was noted that if complete obstruction of the cystic duct was produced after the gallbladder had been emptied of its bile, and the contents replaced with physiologic solution of sodium chloride, there was no evidence subsequently of inflammation in the gallbladder wall. Hydrops ensued. However, when complete obstruction of the cystic duct was performed and bile left imprisoned in the gallbladder, the resulting inflammation varied in severity and type in direct proportion to the content and the concentration of the bile obstructed. This inflammation was identical with that encountered in clinical cholecystitis. This damaging action did not seem to depend on any single substance in bile, but could be shown to be present when various components of the cholic acid derivatives were used. For the most part, these substances appeared to be cholesterol in its various forms, or some of the bile salts.

In a recent study of 354 gallbladders which were removed consecutively in the Barnes Hospital, the author and his coworkers were able to show that in 36, or 10.2 per cent, of the specimens lipoid material resembling cholesterous ester was found in histiocytes beneath the mucosa, giving the characteristic picture of "strawberry" gallbladder. Such a picture was, as a rule, not associated with a great amount of tissue damage in the gallbladder wall, but was frequently found associated with cholesterol gallstones. In 80 cases, or 20.6 per cent of the gallbladders removed, there was microscopic evidence of either lipid or bile deep in the gallbladder wall. In almost every instance these gallbladders were badly damaged, most of them showing evidence of recent acute inflammatory reaction. Thus, including cholesterilosis or "strawberry" gallbladder, there was a total of 116 cases, or 32.8 per cent of the gallbladders removed, in which one could demonstrate some histologic evidence of a lipid or bile reaction in the wall of the gallbladder.

It would now seem that the conception of the etiology of cholecystitis would consider cholesterolosis or "strawberry" gallbladder an early form of cholecystitis. It would not place it in a category apart. It would correlate the association of cholecystitis with precipitation of components of bile in the gallbladder to form stones and the relationship of those stones to inflammation. It would explain why in the gallbladder may be found a varied group of organisms ranging from *Streptococcus haemolyticus* to *Bacillus typhosus* with the identical inflammatory reaction. The type of bacteria present in the gallbladder would depend upon those present in the intestinal tract of that particular individual, while the primary inflammatory process is of different origin.—*Mary Frances Vastine.*

GYNECOLOGY AND OBSTETRICS

KIBEL, ISRAEL. Hyperthyroidism and pregnancy. *Am. J. Obst. & Gynec.*, Oct., 1944, *48*, 553–556.

Most authors agree that hyperthyroidism is a comparatively infrequent complication of pregnancy. In the Bronx Hospital, over a period of six years, 15,864 pregnant women were admitted. Of these, only 12 (or 0.075 per cent) showed abnormal hyperactivity of the thyroid gland. The symptoms of hyperthyroidism developed during pregnancy in 7 cases, antedated the pregnancy in 3 cases, while 2 cases dated their symptoms to a previous pregnancy.

Discussion. Bothe showed the experimental evidence of the relation of the anterior pituitary hormone to the activity of the thyroid gland, whose function is the production of a secretion which activates heat and energy production by

regulating the rate of oxidation in the cells throughout the body. Mussey states that the thyrotropic hormone of the anterior lobe of the pituitary stimulates the thyroid gland to hyperplasia and the production of thyroxin, and causes the release of stored colloid. Overproduction of thyroxin tends to develop an antihormone in the body, which depresses the thyrotropic output of the anterior lobe of the pituitary. The thyrotropic content of the pituitary, therefore, becomes inversely proportional to the thyroxin output of the thyroid gland. Sufficient iodine is also necessary to enable the thyroid gland to discharge all the thyroxin it produces. If the amount of ingested iodine is insufficient for the physiologic demand of the increased metabolism during pregnancy, the appearance of colloid or simple goiter may result. This result may be hypothyroidism in the mother, and if the degree of hypothyroidism is sufficient, it may cause miscarriage or the development of colloid goiter or cretinism in the infant.

On the other hand, if there is a sustained stimulation of the thyroid in conjunction with certain unknown factors, a condition of hyperthyroidism develops. This may occur during pregnancy, or more commonly the woman may become pregnant while the hyperthyroidism exists. Occasionally, cases of what was thought to be toxemia of pregnancy have turned out to be the result of an overactive thyroid gland. Javert, however, states that the high incidence of toxemia of pregnancy (76 per cent) in his series of hyperthyroidism in pregnancy seems significant, and raises the question of a common factor in toxemia and in thyrotoxicosis.

Treatment. All authors agree that it is the thyrotoxicosis and not the pregnancy which should be interrupted. Therapeutic abortion is not indicated except in rare instances. If possible, the woman with hyperthyroidism should be carried to term, and only exceptional cases that grow progressively worse, in spite of adequate and intensive medical treatment, should be thyroidectomized. It should be a dictum that the pregnancy itself should not be interfered with, unless there is an obstetric reason.—*Mary Frances Vastine.*

Gusberg, S. B., and Danforth, D. N. Clinical significance of struma ovarii. *Am. J. Obst. & Gynec.*, Oct., 1944, *8*, 537–542.

There have been 8 cases of struma ovarii recorded in the pathologic files of the Sloane Hospital for Women in the past twenty years. This represents 2.7 per cent of 297 ovarian teratomata of all types which were examined during the same period. The diagnosis of ovarian struma has been confined to those tumors which contain significant quantities of thyroid tissue.

A case is presented in which thyrotoxicosis, a large struma ovarii, and a huge goiter were coexistent.

Discussion. That struma ovarii is capable of producing or at least contributing to thyrotoxicosis, is established. It is this ability which distinguishes the ovarian struma among all ovarian neoplasms.

Cases of functioning ovarian struma may easily escape diagnosis either through failure to appreciate mild hyperthyroid symptoms or through chance avoidance of thyroid tissue in the sectioning of large ovarian teratomata.

In 1940, Enge estimated the recorded cases of struma ovarii at 150 of which 5 to 6 per cent were said to have produced thyrotoxicosis.

It appears reasonable to consider the ovarian struma as a functioning part of the total thyroid tissue of the body, which may react to iodine lack, to the thyrotropic hormone, or to other stimuli in a manner similar to that of the thyroid gland itself. One might then consider the removal of an ovarian struma as tantamount to subtotal ablation of the thyroid gland.

The signal importance of this disease picture is manifested in the case which presents distinct evidence of thyrotoxicosis, plus enlargement of the thyroid gland, plus an ovarian tumor. *Mary Frances Vastine.*

Banner, Edward A., and Dockerty, Malcom B. Theca cell tumors of the ovary; clinical and pathologic study of twenty-three cases (including thirteen new cases) with a review. *Surg., Gynec. & Obst.*, Sept., 1945, *81*, 234–242.

A decade has elapsed since Loeffler and Priesel gave the first accurate description of the ovarian neoplasm now known as thecoma or theca cell tumor. It seems a well established fact that this tumor often produces estrogen sometimes in amounts capable of profoundly influencing the physiologic processes of its host.

This tumor seems to be related on the one hand to the histologically mature fibroma and on the other to the comparatively dedifferentiated granulosa cell neoplasm.

In their paper, the authors present data on 23

cases of theca cell tumor together with a correlation of clinical, pathologic and chemical data.

Clinical Observations

1. *Incidence.* Theca cell tumor is rare. It comprises about 3 per cent of the group of solid ovarian tumors, is about a third as common as the granulosa cell tumor and is less than a tenth as common as the ovarian fibroma.

2. *Age.* The average age of patients who have theca cell tumors is about fifty-four years. Theca cell tumors have not been reported as occurring prior to the age of puberty.

3. *Parity.* Pregnancy had occurred at least one in 80 per cent of this series of patients.

4. *Symptoms.* Irregular vaginal bleeding of the postmenopausal type or gross menstrual irregularities of younger patients existed in more than 60 per cent of the reviewed cases. A triad of symptoms, namely menstrual disturbance, pelvic pain, and pelvic tumor seems to occur fairly constantly in these cases.

On physical examination, the demonstration of a firm adnexal tumor was frequently associated with uterine leiomyomas or an enlarged uterus.

Pathologic Data

1. *Side.* The right ovary was the seat of the tumor in 15 and the left in 8 cases.

2. *Size.* The average diameter of the tumor was about 6 cm. The actual size of the tumor appeared to bear no direct relation to the degree of clinical "function" as measured by the duration or the severity of associated menstrual disturbances.

3. *Color, consistency, etc.* The color varied. The outer aspect was usually smooth and often bosselated presenting tints from gray to yellow. The consistency was generally firm and rubbery. A smooth glistening capsule invested all but two of the tumors. No example of Meigs' syndrome was encountered.

4. *Microscopic features.* Theca cells were demonstrated in all cases. In 4 cases, in addition to the theca cells, the cystologic characteristics and cellular arrangement of granulosa cell neoplasm was encountered.

5. *Contralateral ovary.* Of the 21 contralateral ovaries examined, 20 were somewhat atrophic and 1 was the seat of a benign multilocular cystadenoma.

6. *Condition of the uterus.* The relatively high incidence, especially in postmenopausal patients, of associated myometrial hypertrophy and uterine fibromyomas, combined frequently with endometrial hyperplasia and cervical and fundal carcinoma, suggests the production by these ovarian tumors of estrogenic hormone. (Inability to demonstrate measurable quantities of this hormone through assays of tumor tissue is perhaps not to be regarded as conclusive evidence of absence of the hormone.)

Chemical Studies. A chemical analysis of 8 theca cell tumors gave evidence that these tumors contained increased amounts of cholesterol and cholesterol ester fractions as compared with the values for these substances found present in 7 normal ovaries.—*Mary Frances Vastine.*

GENITOURINARY SYSTEM

NORFLEET, C. M., JR. Bilateral crossed renal ectopia; case report. *J. Urol.*, July, 1945, *54*, 10–11.

Only 23 cases of bilateral crossed renal ectopia had been reported by 1943. The author adds a case in a twenty-nine year old American soldier. In June, 1943, this soldier first complained of mild intermittent non-radiating right lower quadrant pain. By August, 1943, the pain had become progressively worse and was increased by standing, cough and hard work. Burning on urination had been present for one week on admission in September, 1943. Physical examination disclosed a mass in the right lower abdomen, 8 by 4 cm., which displaced the ileum anteriorly as demonstrated by serial study of the gastrointestinal tract.

Intravenous urography was not done because no medium was available. Retrograde pyelography revealed both kidneys lying in the right middle and lower abdomen. The pelvis of the right or uppermost kidney was directed laterally and the right ureter entered from the lateral aspect. The right ureter was short. The fused second kidney overlay the sacrum and could not be separated from the right kidney. Some clubbing suggestive of fetal kidneys was noted in this second kidney. The ureter for this kidney was shorter than the right and crossed the midline to enter the bladder.—*R. M. Harvey.*

GOYANNA, R., and GREENE, L. F. The pathologic and anomalous conditions associated with duplication of the renal pelvis and ureter. *J. Urol.*, July, 1945, *54*, 1–9.

Complete duplication of the renal pelvis was found in 1.25 per cent of consecutive autopsies at the Mayo Clinic, 2,000 cases being examined. Such duplication is only of significance when associated with pathological conditions. In a ten year period at the Mayo clinic 131 patients had 154 pathological or anomalous conditions associated with complete duplication of the renal pelvis. Bifid pelves were not included. Hydronephrosis or hydroureter or both were the commonest complications, the lower pole of the right kidney being affected twice as frequently as the lower pole of the left. The authors advance the theory that the cause for the development of the hydronephrosis may lie in the angle at which the ureter from the lower segment joins that from the upper. Faulty drainage may explain the higher incidence of infection in the lower than in the upper segment.

The diagnosis must be made by cystoscopy or excretory urography, the latter being effective only if both segments are functioning. In the event that one segment does not function, the diagnosis may be suspected from elongation of the renal shadow, a large region of kidney with no visible means of drainage or from the shape of the visualized pelvis. The upper segment is usually small, with two major calices. The upper calyx of the lower segment extends laterally rather than superiorly. Cystoscopy is usually necessary to make the diagnosis of complete reduplication of the ureters.

The authors cite 3 cases with illustrative roentgenograms to demonstrate the difficulties encountered in the diagnosis of duplication.—*R. M. Harvey.*

Shearer, T. P., Wiper, T. B., and Miller, J. M. Renal carbuncle; new method of treatment. *J. Urol.*, July, 1945, *54*, 12–16.

Mortality statistics favor nephrectomy in the treatment of renal carbuncle. Advances in the treatment of renal carbuncle have been delayed by the infrequency of the lesion. Only 100 cases have been reported. Most cases have occurred in the third decade and are preceded by a cutaneous infection. The symptoms are seldom localized to the urinary tract but are generalized. Malaise, prostration, chills and fever are the usual complaints. The carbuncle may rupture into a calyx or into the perinephric space.

The authors treated a case of renal carbuncle successfully by incision and drainage, combined with local and systemic penicillin. Intravenous pyelogram revealed compression of some of the calices of the affected kidney. The diagnosis was based on the history of preceding infection of the skin, septic temperature, tenderness in the costovertebral angle plus the pyelographic picture. A retrograde pyelogram after incision and drainage of the carbuncle revealed a normal appearance of the previously compressed calices.

The authors urge more frequent use of excretory and retrograde pyelography in the investigation of cryptogenic fever which may originate in the urinary system.—*R. M. Harvey.*

Levine, B. Aneurysm of the renal artery. *J. Urol.*, July, 1945, *54*, 17–21.

Only 76 cases of aneurysm of the renal artery have been reported and only 13 of these were diagnosed prior to operation or death. The author reports a case in a fifty-nine-year old woman who complained of abdominal pain in the upper abdomen which was proved to be due to duodenal ulcer and pain in the right loin of fifteen years' duration. A gallbladder series revealed a wreath-like calcific shadow medial to the right kidney. A right retrograde pyelogram showed no abnormality of the right kidney but did show the calcific shadow revealed on the gallbladder examination to move with the kidney, and a diagnosis of aneurysm of the renal artery was made.

Laminagrams of an excretory urogram showed the calcific shadow to lie in the same plane as the right renal pelvis. Operation confirmed the diagnosis of aneurysm of the renal artery. The aneurysm was removed together with the right kidney and the patient made an uneventful recovery. The author stresses the value of laminagraphy in the diagnosis of such a lesion.—*R. M. Harvey.*

Huff, F. M., and Boger, W. P., Jr. Renal hypoplasia with hydroureter and primary amenorrhea. *J. Urol.*, 1945, *54*, 116–122.

Anomalies of the genital and urinary tract are frequent coincidental findings. The authors report a case illustrating this point. Their patient was a twenty-six year old white female who complained of never having menstruated. Various types of endocrine and estrogenic therapy had been tried without success. Normal secondary sexual characteristics were present. Abdominal palpation disclosed a large mobile

mass in the right upper quadrant and a similar but smaller mass on the left. The uterus could not be definitely palpated. A survey film of the abdomen revealed a large right renal shadow. No evidence of a left kidney was evident even after excretory urography. Cystoscopic examination showed a normal right ureteral orifice and kidney. The left ureteral orifice was small and no urine was seen to come from it. A right retrograde pyelogram was normal while a left retrograde pyelogram revealed a large left ureter without evidence of a kidney pelvis.

Operation disclosed a very small left kidney and a dilated left ureter. A pair of large vessels crossed the ureter 7 cm. above the vesical outlet. Hysterography at a later date disclosed a rudimentary uterine cavity. The authors feel that the small kidney was not due to atrophy following long-continued obstruction in the lower urinary tract but was due to true hypoplasia. They emphasize the frequency of concomitant anomalies of the genital and urinary tracts which is almost certainly based on their common anlage. In a case such as is reported here endocrine therapy is futile.

The authors conclude that the urinary tract should be investigated in all cases of primary amenorrhea.—*R. M. Harvey.*

Tahara, C., and Hess, E. Massive renal fibrolipoma. *J. Urol.*, Aug., 1945, *54*, 107–115.

The authors report 2 fibrolipomas which were of interest because of their massive size and because of concomitant hypertension which was relieved by removal of the tumors and the adjacent kidneys. The first case was that of a fifty-four year old woman who complained of a mass in the right abdomen which produced a dragging sensation accompanied by anorexia and weight loss. The mass was known to have been present for eight years. Symptoms had been insignificant for seven of these eight years. The blood pressure was 150/100. The mass extended from the costal cage to the pelvic brim and to the midline. An intravenous urogram revealed a hydronephrotic right kidney pelvis which was displaced to the midline and up beneath the diaphragm. A right nephrectomy was followed by relief of the hypertension. The mass removed at operation measured 12 by 16 by 29 cm. Histopathological examination revealed a large fibrolipoma which was intracapsular and a hydronephrosis and chronic pyelonephritis of the right kidney.

The second case also exhibited an abdominal mass, weight loss, and hypertension. The mass in this case was extrarenal and displaced the normal kidney toward the midline. In this case the histological report was also fibrolipoma but in this case the tumor was perirenal. Following nephrectomy the blood pressure was reduced although not to a normal reading. The involved kidney was also the seat of a chronic pyelonephritis.—*R. M. Harvey.*

Hayward, W. G. Multiple primary tumors. *J. Urol.*, Sept., 1945, *54*, 307–311.

The author reports a case of an eighty-two year old male who had a basal cell carcinoma excised from the perineum in July, 1941, an epidermoid carcinoma was removed from the left groin in May, 1942, an adenocarcinoma of the prostate was removed following urinary retention in June, 1942, and finally bilateral orchiectomy following removal of the malignant prostate revealed a seminoma of the left testicle. Lombard and Warrens recently stated that "there is a greater susceptibility to cancer in persons having one cancer than in the normal population" and this case would certainly seem to bear out this statement.—*R. M. Harvey.*